1992 NASA AUTHORIZATION

HEARING

BEFORE THE

SUBCOMMITTEE ON
TECHNOLOGY AND COMPETITIVENESS

OF THE

COMMITTEE ON
SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

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1992 NASA AUTHORIZATION

TUESDAY, MARCH 5, 1991

U.S. HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
SUBCOMMITTEE ON TECHNOLOGY AND COMPETITIVENESS,
Washington, D.C.

The subcommittee met, pursuant to recess, at 9:30 a.m. in room 2318, Rayburn House Office Building, Hon. Tim Valentine [chairman of the subcommittee] presiding.

Mr. VALENTINE. Good morning, ladies and gentlemen. The subcommittee will come to order. We are not at this point deluged by members but they will come in and out as we proceed.

This is a hearing on the NASA development of new technology for the advancement of U.S. aeronautics. We are pleased to be able to participate and hopefully make a contribution.

The annual aeronautics product of the United States exceeds $90 billion, and that provides the best of our favorable industrial trade balance of some $25 billion. Aeronautics is an industry that employs about one million Americans. Further, our aeronautics industry gives us our U.S. air transportation. This system is the leading inter-city carrier, which transports the equivalent of twice the U.S. population yearly, a substantial product in its own right.

I need not remind anyone of the Desert Storm reliance on this technology. I am determined that we will continue to pursue improvement in the excellence of our world leadership in this area. That is the sole purpose of our meeting here today. We will review at this session of the subcommittee the Administration's budget request for aeronautics R&D and programs and supporting facilities

This fiscal year 1992 budget request amounts to some $1 billion. A question we have is whether or not this is adequate, or is it more that adequate? Does it focus on our primary goals as reflected in our aeronautics policy? Are there duplications? Have we left any critical issues unaddressed? These are the kinds of questions and answers we need for the record.

On March 12, with the Armed Services Subcommittee on Research and Development, the appropriate subcommittee, we will address the part of NASA's aeronautical budget which is their share of the National Aerospace Plane program, in which they participate with DOD. We will not pursue that subject in depth here today.

I have a procedural comment. In order to facilitate the proceedings of the subcommittee and afford members who come in an opportunity to participate and ask questions—incidentally, let me say parenthetically that we will endeavor to recognize members of the subcommittee based on when they come to the meeting, not on seniority. To return to my main procedural request, the witnesses' prepared statements will go into the record as you submitted them to us. We respectfully request that you condense or summarize your statements and limit them to five minutes each, if you will.

I would like to welcome here today, first of all, our first witness, Mr. Arnold D. Aldrich, the Associate Administrator of Aeronautics, Exploration and Technology with NASA. He has brought his team of Rosens—Dr. Rosen and Mr. Rosen. Is this a family operation or an unwholesome coincidence?

[Laughter.]

Mr. VALENTINE. At any rate, if Mr. Aldrich was a member of Congress and appeared here with these two gentlemen I would say he comes with the statement and they come with the answers. But I am sure that it is a combination of both. We welcome you and will be glad to hear what you have to say.

But before that, of course, we have been joined by a distinguished member of the subcommittee, the Honorable Dana Rohrabacher, from California. Do you have an opening statement?

Mr. ROHRABACHER. Just a brief one, Mr. Chairman. I come from a district that is very heavily into aerospace. In California, in Southern California in particular, we understand the importance of aerospace to our economy. I think it is so important that America look 10 years down the road instead of just one year down the road, in making sure our aerospace industry remains the predominant aerospace industry in the world.

I have a great deal of concern that if we don't watch out, in the next century America will not be the predominant aerospace country in the world. That will have grave implications for the U.S. economy as a whole.

I am especially concerned about technology transfer, especially to Japan, in which our money that is being spent for the Department of Defense, we are spending billions of dollars in research and development that should be going into our aerospace firms and making them impregnable to foreign competition.

Instead, we are selling, through joint ventures and other types of technology transfers, we are selling our capabilities to Japan for hundreds of millions of dollars, for which we have spent billions of dollars developing in the Department of Defense. This is of great concern to me, and I will be looking forward to hearing your testimony and asking you your reaction to some of the observations I have just made.

Thank you very much, and thank you, Mr. Chairman.

Mr. VALENTINE. Thank you. Mr. Aldrich?

[The prepared opening statement of Mr. Valentine follows:]

HON TIM VALENTINE, CHAIRMAN
TECHNOLOGY & COMPETITIVENESS SUBCOMMITTEE
NASA FY '92 AERONAUTICS
R&D AUTHORIZATION HEARING

OPENING STATEMENT

Good morning ladies and gentlemen. This hearing is on the NASA development of new technology for the advancement of U.S. aeronautics. I am immensely proud to be able to participate and hopefully contribute in this area.

The annual aeronautics product of the United States exceeds $90 billion, and that provides the best of our favorable industrial trade balances of some $25 billion. Aeronautics is an industry that employs around 1 million Americans. Further, our aeronautics technology gives us our U.S. air transportation system. This system is the leading intercity carrier that carries the equivalent of twice the U.S. population yearly, a substantial product in its own right. And, I need not remind anyone of the Desert Storm reliance on aeronautical technology.

There is something very American about that portfolio and this Chairman knows that is no accident. I am determined that we continue to pursue improvement in the excellence of our world leadership in aeronautics. That is our sole purpose for being here today.

Today we will review the Administration's budget request for aeronautics R&D and programs and supporting facilities. This FY 1992 budget request amounts to some $1 billion dollars. Is this adequate? Is it more than adequate? Does it focus on our primary goals as reflected in our aeronautics policy? Are there duplications? Have we left any critical issues unaddressed? These are the kinds of questions and answers that we need for our record.

On March 12th, with the Armed Services Committee on R&D, we will address the part of NASA's aeronautical budget which is their share of the National Aero-Space Plane program in which they participate with DOD. So we will not pursue that subject in depth today.

I have a procedural comment. We would like to limit oral statements to about a five minute summary of key issues. The full written statements submitted will be published in the hearing record. In this manner we will be able to devote our hearing more to answering questions in the minds of the members.

I would like to welcome all of our witneses. Our first witness we know very well. Mr. Arnold D. Aldrich is Associate Administrator of NASA for Aeronautics and Exploration Technology. What an interesting title.

STATEMENT OF ARNOLD D. ALDRICH, ASSOCIATE ADMINISTRATOR, OFFICE OF AERONAUTICS, EXPLORATION AND TECHNOLOGY, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION; ACCOMPANIED BY: ROBERT ROSEN, DEPUTY ASSOCIATE ADMINISTRATOR, AND CECIL ROSEN, DIRECTOR FOR AERONAUTICS

Mr. ALDRICH. Thank you, Mr. Chairman. Bob Rosen is my Deputy, and Cecil Rosen is NASA's Director for Aeronautics.

NASA's aeronautics program is built upon a foundation of over 75 years of excellence and innovation. It provides a broad base of advanced technology and continues to strengthen United States leadership. Our program supports an industry which plays a vital role in economic strength, transportation infrastructure, and national defense, which are required for the Nation's long-term wellbeing.

In 1990, as you pointed out, Mr. Chairman, aeronautical products provided a $28 billion positive contribution to the Nation's balance of trade, and provided 1 million U.S. jobs. Current world events also clearly demonstrated that our high technology aviation systems are superior in performance and reliability to any other in the world.

However, the challenge to our leadership continues to grow, both from the increasing number and the commitment of foreign competitors who are introducing advanced technology products in virtually every segment of the world-wide aviation market. We see the next major plateau in international competition to be high-speed civil air transportation. With sufficient technology development, future high-speed aircraft can have a productivity advantage over today's long-range subsonic aircraft, and we think they can capture a significant portion of the rapidly growing intercontinental market.

The United States will require a concerted research effort in this decade to compete effectively for the multi- billion dollar market in the 21st century. To meet this challenge, NASA's high-speed air transportation thrust has been planned in two phases. The first is directed at three environmental compatibility issues: atmospheric effects from engine exhaust emissions; airport community noise; and sonic boom. The second phase will establish a technology foundation for subsequent industry decisions regarding aircraft development.

Significant progress has been made in phase one laboratory testing, however, this testing has shown that solutions to low-emission combustion and low noise exhaust issues will require the development of new, lightweight, high temperature engine materials, to permit design of an economically viable aircraft. The time required for advanced materials development dictates that we accelerate our research now to ensure their availability when needed.

Therefore, in addition to the planned expansion of our environmental research in 1992, we have also included an element focused on the development of a new class of ceramic based materials for propulsion systems. While focusing on these critical technologies for high-speed transports, NASA recognizes the continued importance of efficiency and safety in our current subsonic air transportation. Accordingly, our 1992 program places increased emphasis on aircraft safety and on selected high leverage technologies for efficient subsonic transports.

For example, in the area of aging aircraft structures, we are accelerating our research in life prediction methods and on advanced structural inspection techniques. We are coordinating closely with industry and the FAA to ensure that the new detection and analysis methods can be readily applied.

On a broader front, we have strengthened our partnership with the FAA and in other safety and aviation system capacity related research. Prominent examples include wind shear hazard detection and avoidance, air traffic control automation, and aviation human factors.

NASA's ability to bring timely and innovative focus to these and other high priority technologies results in part from our talented personnel and our unique national facilities. For example, our Numeric Aerodynamic Simulation program continues to provide the pathfinding supercomputer capabilities that enhance our leadership in computational aerosciences. These efforts are closely coupled with our high performance computing research, which is exploring new parallel processing architectures and software capable of revolutionary increases in computation rates.

This research is coordinated with other government agencies and is a key element of the new National High Performance Computing and Communications program.

While these computational thrusts represent relatively new national roles for our aeronautics program, NASA's unique wind tunnels have historically been among our most important national facilities. We remain committed to the task of insuring that these critical facilities are available for high priority industry, NASA and DOD programs. 1992 is the fourth year of our major Wind Tunnel Revitalization Program, which is being complemented by facility maintenance and instrumentation enhancements, which began in 1991.

In conclusion, Mr. Chairman, NASA is convinced that technology is a crucial element in maintaining this Nation's leadership in aeronautics. Our 1992 budget request reflects a critical assessment of the highest priority research and technology that we must pursue to keep the United States the world leader in aviation.

Thank you, Mr. Chairman. I am happy to answer any questions you have.

[The prepared statement of Mr. Aldrich follows:]

NASA
National Aeronautics and
Space Administration

Hold for Release Until
Presented by Witness

March 5, 1991

Subcommittee on Technology and Competitiveness

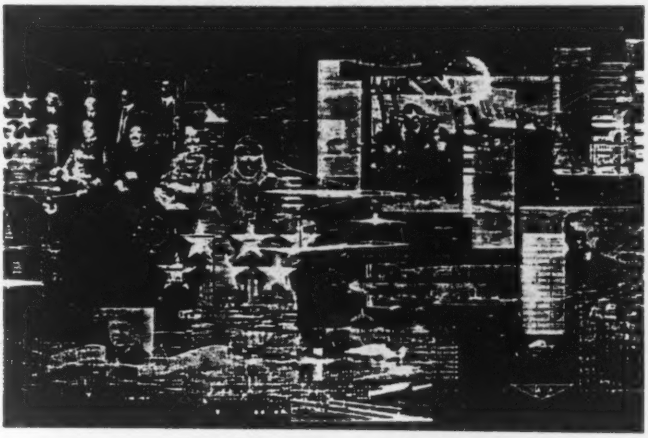
Committee on Science, Space and Technology

House of Representatives

Statement by:

Arnold D. Aldrich
Associate Administrator
Office of Aeronautics,
Exploration and
Technology

AERONAUTICS



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102nd Congress

STATEMENT

of

Mr. Arnold D. Aldrich
Associate Administrator for
Aeronautics, Exploration and Technology

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

before the

Subcommittee on Technology and Competitiveness
Committee on Science, Space and Technology
United States House of Representatives

Mr. Chairman and Members of the Subcommittee:

I am pleased to present NASA's FY 1992 Aeronautics Research and Technology budget request. The NASA program provides a broad foundation of advanced technology to strengthen the United States' leadership in aeronautics, an industry which plays a vital role in the economic strength, transportation infrastructure, and national defense required for the long-term well-being of the United States. The budget reflects our awareness of the current tight fiscal environment while recognizing that investments in high priority NASA Aeronautics research and technology have very high leverage for future returns and are essential for long-term U.S. aviation leadership.

NASA's Aeronautics Program is built upon a foundation of 75 years of excellence and innovation in research and technology. Throughout this period, NASA and its predecessor, the National Advisory Committee for Aeronautics (NACA), utilizing talented researchers and unique research tools, have established a rich heritage in aeronautics research and have forged a strong partnership with industry, academia, the Federal Aviation Administration (FAA), the Department of Defense (DoD), and other government agencies. This partnership has propelled our nation to preeminence in aviation. Today our aviation industry is a major contributor to commerce, transportation and national defense. In 1990, aeronautical products provided a $28 billion positive contribution to the country's trade balance and the aeronautics industry provides approximately one million U.S. jobs.

Our civil and military aircraft are superior in performance and reliability to any in the world. Current world events clearly demonstrate that our high technology aviation systems are the cornerstone of our national security. Even now, long-range pioneering R&T is addressing the critical technology issues for future industry decisions on high-speed civil transports to position the U.S. for continued leadership into the 21st century. But, the challenge to U.S. leadership continues to grow from increasing numbers of international competitors and their national commitments to the investments required to further strengthen their competitive posture.

Foreign firms continue to introduce advanced technology products developed to compete for even broader segments of the worldwide aviation markets. European manufacturers now have introduced competitive aircraft for virtually every segment of the civil transport market, from short-haul commuters to long-range trans-Pacific transports. Other countries with demonstrated high technology capabilities are establishing aggressive programs and plans for aerospace capabilities that target specific future aviation markets. The U.S. must continue to pioneer new technological advances in aeronautics if we are to remain as world leaders in aviation.

In addition, the need to focus on maintaining the productivity and safety of our national air transportation system grows increasingly important. Passenger revenue miles have tripled since 1970 and are expected to double again by the year 2000, further straining airport capacity and increasing the frequency of costly and annoying delays. New aircraft and propulsion concepts must be designed to operate efficiently and safely in congested airspace while addressing increasing environmental concern for airport community noise. Unique aircraft concepts such as tiltrotors must be evaluated for commercial viability and for innovative applications to reduce airport congestion. Existing aircraft are a growing concern, as U.S. airlines enter the 1990's on the wings of the oldest civilian fleet in history.

NASA's strategy for aeronautics research and technology represents a vigorous, and appropriate, response to the overall aviation environment. Our programs continue to emphasize high-payoff emerging technologies, ensure the health and productivity of unique laboratories and facilities and address critical barriers to the introduction of new technologies and aircraft concepts. To implement this strategy we are pursuing six key thrusts:

- **Subsonic Transports** - develop high-leverage technologies to ensure future competitiveness of U.S. subsonic aircraft and to enhance the safety and productivity of the National Aviation System

- **High-Speed Air Transportation** - resolve the critical environmental issues and establish the technology foundation for future decisions for economical, high-speed air transportation

- **High-Performance Aircraft** - provide technology options for revolutionary new capabilities in future high-performance fixed and rotary wing aircraft

- **Hypersonics/Transatmospherics** - develop critical technologies to support the development of future hypersonic and transatmospheric vehicles

- **Critical Disciplines** - pioneer the development of the fundamental knowledge base to maintain the theoretical, experimental, and predictive foundation required for the design and operation of advanced aerospace systems

- **Critical National Facilities** - develop, maintain and operate critical national facilities for aeronautical research and for support of industry, DOD, and other NASA programs

NASA has formulated its aeronautics program in line with these six strategic thrusts to focus on selected high-leverage technologies that address key issues in each area. The FY 1992 budget request, summarized in Figure 1, supports this plan with particular emphasis on addressing environmental issues and enabling propulsion materials associated with high-speed air transportation, developing advanced composite materials technology for future airframes and engines, continuing our strong partnership with FAA in addressing airspace congestion and aircraft safety, maintaining our commitment to a strong national facility capability, and cooperating with other agencies in an aggressive national high-performance computing and communications program.

In line with our thrust in **Subsonic Transports**, our FY 1992 program places increased emphasis on aircraft safety and on selected high leverage technologies with substantial payoff in future transport aircraft designs. The Advanced Subsonic Technology program, planned for initiation in FY 1992, will augment our activities in aging aircraft and introduce a thrust in electro-optical flight control and electromechanical power management technology.

Advanced structural inspection and life prediction methods are the major focus of our aging aircraft research. Non-Destructive Evaluation (NDE) sensor techniques are being developed which will enable detection of disbonds, fatigue cracks and corrosion during aircraft service inspections. A unique but practical thermal imaging method for detecting structural disbonds was recently developed and demonstrated at NASA's Langley Research Center. Advanced signal processing concepts were used to display wide-area inspection of fuselage structure problem areas. Fracture analysis methodology is being developed for multi-site damage fatigue crack analysis to complement the NDE development. NASA and FAA are cooperating to develop an overall strategy for aging aircraft research and initial planning has begun for a joint NASA/FAA-sponsored Conference on Aging Aircraft and Structural Airworthiness for November 1991.

Research directed at advanced aircraft flight control and power management systems utilizing emerging electrical and optical concepts is also slated for increased emphasis. These advanced concepts are expected to replace current systems that use hydraulic control and electronic data transmission. The new electro-mechanical controls and fiber-optic data transmission technologies can reduce aircraft weight and provide highly-redundant distributed systems that are resistant to electromagnetic interference as well as failure due to localized damage to the aircraft. Our goal is to provide the enabling technology and methodology base for these fly-by-light and power-by-wire systems that will have the performance, reliability and useful life suitable for certification in civil transport use. We will expand our ongoing research in electro-optic sensors, actuators and architectures being conducted in cooperation with the Navy for fiber optic control integration applications. In this activity, an electro-optic architecture design has been completed and we will flight test a NASA-developed fiber-optic rotary position sensor this year. Our expanded activity will develop, integrate and verify in ground tests a full suite of electro-optic components with fault tolerant architectures and software, providing the basis for industry design and FAA certification of civil transport systems.

A major focus of our advanced subsonic transport thrust is to develop materials and structures technologies for innovative and cost-effective advanced composite primary airframe structures such as fuselage structural frames, window belts and sub-floor design concepts. Advanced fiber placement techniques have demonstrated the viability of multi-axis filament winding for new fuselage design concepts for transport aircraft (Figure 2). This fabrication concept demonstrates the potential for 40-50 percent weight reduction and 30 percent cost savings over conventional metal construction. Efforts in FY 1992 will include testing of fuselage panel concepts to understand and predict structural performance for this fabrication technique. Investigations will continue on woven textile preforms, pultrusion methods and resin transfer molding to provide cost effective design and fabrication technology for utilization of advanced composite primary structures in the next generation of civil transport aircraft.

NASA is also working with the FAA in a national cooperative program to develop the technologies and capabilities to avoid the consequences of hazardous windshear in aircraft landings and takeoffs. We are investigating the physics of the windshear phenomena and developing improved models to assess sensor requirements and performance. We are also developing and evaluating in-flight sensors that utilize Doppler radar and light detection and ranging (lidar) and infrared technologies (Figure 3). Recent FAA/NASA/Lincoln Laboratory flight tests conducted at Orlando International Airport achieved, for the first time, realtime airborne remote detection of microbursts using NASA/industry-developed infrared sensing technology. Our goal is to provide for remote sensing of microbursts to warn pilots of windshear danger in time for them to safely compensate or abort the landing.

NASA is developing advanced automation technology, for applications in both cockpit and ground systems, to increase safety and capacity at our crowded airports. The Ames Research Center has developed an advanced air traffic control (ATC) automation system for scheduling, sequencing, and controlling traffic in an extended terminal area (Figure 4). This system has demonstrated increases of approximately 15 percent in traffic capacity and at the same time, increasing controller productivity. It was recently installed at the FAA Technical Center for further testing and development prior to field installation and test. In conjunction with this ATC automation capability, advanced data link concepts that interconnect advanced cockpit and ATC ground operations have been developed and demonstrated on NASA's Boeing 737 research aircraft.

NASA is working closely with the FAA in the development and implementation of a national strategy for increasing the emphasis on human factors as an integral element in the design and development of advanced aviation systems. In 1988, Congress directed the FAA to develop a National Aviation Human Factors Plan and to coordinate its efforts with NASA. The national plan, currently in draft form, addresses the need to properly consider human factors in all aspects of the National Aviation System and provides a framework for a national strategy for human factors aviation research. Scientific experts, organized in technical planning groups, developed the plan based on eight areas of high national priority. The draft plan was summarized at an international conference, "Challenges in Aviation Human Factors: The National Plan," in January 1991. The plan will be used as a guideline by NASA and FAA for planning and coordinating future human factors aviation research.

NASA is also redirecting propulsion R&T efforts toward ultra-high-bypass ratio ducted fans, which are typical of the anticipated propulsion systems for the next generation of lower noise transport aircraft. Acoustic treatment concepts for thin, low drag nacelles to attenuate fan blade noise are integrated with engine/airframe designs to minimize noise generation and propagation. Recent research has resulted in a wing/nacelle integration concept that exhibits favorable interference characteristics for an advanced subsonic configuration. In conjunction with source noise reductions, modified flight procedures utilizing efficient high-lift systems are being investigated to reduce the effects of noise on communities adjacent to airports. This integrated approach to airport terminal area noise reduction is being accomplished through coordinated research in propulsion and aerodynamics.

Aerodynamics technologies are pursued to enable design of integrated transport wing concepts which emphasize optimum performance in all flight regimes. These concepts incorporate high-lift system designs and drag reduction concepts that reduce airport community noise and improve aircraft economic performance. In recent research in drag reduction aerodynamics, NASA conducted Hybrid Laminar Flow Control (HLFC) flight experiments on a Boeing 757 in a cooperative effort with the U.S. Air Force and The Boeing Company (Figure 5). The results established both low drag performance gains and operational feasibility of the concept. Future research will focus on experimental validation of advanced high-lift system design methods and the integration of drag reduction, propulsion and high-lift systems.

NASA's major thrust in research for **High-Speed Air Transportation** was expanded in FY 1990 and is directed at the critical environmental compatibility issues of atmospheric impact, airport noise and sonic boom that present major barriers to a next-generation high-speed civil transport. With sufficient technology development, future high-speed aircraft could be competitive with subsonic aircraft, and capture a significant portion of the growing long-haul intercontinental market, especially in the transpacific sector where travel is projected to quadruple by the turn of the century. High-speed transports will be the next plateau for international competition in aviation. Both British Aerospace and Aerospatiale continue to study a successor to the Concorde, and in May 1990 reached agreement on a joint 3-5 year study. Similarly, late in 1989, Rolls-Royce and Snecma signed a joint agreement to pursue the feasibility of new engine concepts necessary for environmental acceptance and viable economics. Interest in a next-generation high-speed transport is not limited to European companies. In late 1989, Japan initiated a Supersonic/Hypersonic Technology Project through its Ministry of International Trade and Industry (MITI) beginning with an eight year, ~$200M effort targeted at development of a high-speed aircraft propulsion system. The project is also focussing on new high-temperature materials needed to meet engine and airframe demands at this speed range, and definition of test facilities in support of these development goals. This foreign interest and investment in high-speed transport research only serves as a reminder that a share of this multi-billion dollar future market will not be won without a concerted national research effort. By addressing the key technologies that will resolve the environmental barriers and lead to viable economics, NASA's High-Speed Research Program is helping assure that the U.S. will be well prepared for discussions on this next plateau of competition.

Although the High-Speed Research (HSR) program has only been in place for a little over a year, significant progress has been made in the atmospheric impact and airport noise reduction elements.

The goal of atmospheric modelling research is to refine and adapt existing theoretical models to evaluate potential ozone depletion effects due to high-speed transport engine exhaust emissions in the lower stratosphere. In January 1991, NASA's HSR Atmospheric Advisory Committee met to review the ongoing atmospheric modelling being performed by international scientists in support of the program. Progress was encouraging and efforts will be expanded during the coming year to understand and resolve some anomalies among the theoretical predictions and to enhance the models' capability to address unique high-speed civil transport conditions. Recent laboratory testing of one low-emissions combustion concept also shows considerable promise in meeting the emission index goal of less than six grams equivalent NO_2 per kilogram of fuel by demonstrating values between two and three grams at near-cruise simulated operating environment (Figure 6).

In the engine source noise reduction area, 12-18 dB noise suppression has been demonstrated in acoustic testing of two small mixer-ejector nozzle models (Figure 7), thereby showing significant potential for achieving noise impacts comparable to FAR 36-Stage 3, the current requirement for new subsonic aircraft.

NASA's sonic boom research is focused on establishing the feasibility of reducing sonic boom sufficiently for overland supersonic flight. This element is focusing on two key areas: the feasibility of minimizing the pressure wave through aircraft reshaping while maintaining needed aerodynamic performance; and establishing human acceptance criteria. Small-scale model wind tunnel tests are now underway to quantify the former, and a sonic-boom simulator just recently received approval for human use for developing the needed database on the latter.

In meeting the challenge of environmental acceptability, both of the candidate low-NOx combustor concepts preclude the use of internal cooling now applied extensively in current aircraft combustor configurations, and will place a severe additional thermal demand on materials. Similarly, the length and mechanical complexity of the exhaust nozzles necessary for low noise levels will require much lighter-weight, high-temperature materials than are currently available to be economically viable. Both requirements place a demand on material properties that cannot be met with today's technology. The FY 1992 Enabling Propulsion Materials augmentation addresses these demanding requirements by accelerating development of a new class of ceramic-based composite materials capable of operating uncooled to 3000°F for the combustor, and high-temperature, high-strength intermetallic composites to reduce jet exhaust nozzle structural weight. As the development and introduction of new materials have historically required from 12-15 years, efforts on these new materials must start now to ensure their availability by the 2005 entry-into-service projected need date. Early work will focus on advanced high-temperature fibers that are critical to both of these composite material systems.

Our thrust in **High-Performance Aircraft** is focused on providing a proven technology base to enable maneuverability and agility of fighter aircraft at twice the current capabilities and to expand the technology base for supersonic short take off/vertical landing (STOVL) aircraft and advanced military rotorcraft.

NASA continues to cooperate with DoD to provide technology options to enable superior military aircraft. In fixed wing fighter aircraft technology, NASA is focusing on high payoff technologies for high angle-of-attack agility and integrated systems to enable optimization of aircraft control effectiveness in all phases of flight. Key elements of the program are high angle-of-attack aerodynamics, integrated flight/propulsion controls and maneuver management. We have completed a comprehensive correlation of data from computational analysis, wind tunnel testing, and flight tests for aerodynamic flow fields about a typical fighter aircraft. A thrust vectoring control system (Figure 8) has been designed and installed on NASA's F/A-18 high alpha research vehicle at the Dryden Flight Research Facility which has begun flight tests to evaluate enhanced maneuver capability at extreme angles-of-attack. Key research and technology elements for the supersonic STOVL include experimental and analytical investigations of the aircraft/ground interaction environment, propulsive lift system components and their integration, and flight propulsion-controls integration. Wind tunnel research on jet exhaust temperature effects on thrust augmentation ratios for ejector augmented lift systems, early flights of the newly modified YAV-8B Harrier VSTOL Systems Research Aircraft (VSRA) and new computational results for powered-lift flowfields are enhancing our ability to understand and resolve technical barriers to the design and operation of STOVL aircraft. These R&T developments will provide the knowledge base for selected advanced technology options for the next generation of fighter aircraft.

Critical technologies for high performance rotary wing aircraft are being developed to enable higher speeds, lower noise levels, higher combat agility and automated nap-of-the-earth (NOE) flight in low visibility conditions. Innovative research is being pursued in close cooperation with the Army for pilot-centered autonomous concepts and advanced rotor systems including active rotor state control for high agility and low vibration. We have developed and implemented the first fully automated NOE guidance concept in a workstation simulation environment. These basic research results are strongly supported by cooperative flight research with the Army and rapidly transferred to their technology base for future applications.

Our **Hypersonics/Transatmospherics** thrust is to develop critical technologies to support the development of future hypersonic and transatmospheric vehicles. NASA's primary focus is the National Aero-Space Plane (NASP) program, a major national effort to develop, and then demonstrate in flight, the most critical technologies to enable single-stage-to-orbit with airbreathing primary propulsion. The NASP program is complemented by a fundamental research effort that focuses on the key physical and chemical processes which significantly affect the performance of hypersonic vehicles and engines.

Major areas of focus in hypersonic/transatmospheric aerodynamics and aerothermodynamics are boundary layer transition at high Mach numbers and propulsion/airframe integration. The latter is a crucial area with substantially more importance for hypersonic vehicles than for any other vehicle class. Propulsion research includes emphasis on turbulent mixing at supersonic speeds, including mixing enhancement concepts which could enable maximization of thrust potential at very high flight speeds. Exhaust flow physics is an important aspect of the integrated propulsion flow path analysis methodology being developed. Materials research incorporates very high payoff metal matrix composites which are no longer being pursued in the NASP program. Structures efforts continue to deal with unique hypersonic aerothermal loads and cooled concepts to cope with these loads. Since the technical challenges for hypersonic vehicles are inherently multi-disciplinary, a crucial component of the research involves methodologies to integrate and couple the component technologies.

Within our **Critical Disciplines Research,** NASA is pioneering a broad fundamental knowledge and technology base that is critical to the design of all future advanced aeronautical systems. We are pursuing the development of innovative concepts, the physical understanding and the theoretical, experimental and computational tools that provide the foundation to keep this nation preeminent in aviation. We seek to develop and validate basic advances in the aeronautical disciplines of fluid dynamics, combustion and chemistry, materials and structures, controls, human factors and computer science. These single disciplines are integrated through development of multidisciplinary methodologies and optimization techniques that enable the design and analysis of advanced vehicle systems.

The Numerical Aerodynamic Simulation (NAS) program continues to support NASA's pathfinding supercomputer capability, providing a national computational facility to ensure continuing U.S. leadership in computational fluid dynamics (CFD) and related computational aerospace disciplines. The NAS currently has two supercomputers (a Cray-2 and a Cray-YMP) used nationally by 1600 researchers at 122 sites (Figure 9). Two new sites were added in FY 1990 and four new sites are planned in FY 1991. In FY 1992, the Cray-2 will be replaced by a next generation high-speed processor operating initially in a pathfinding role.

The NAS program is also involved in research to use massively parallel computer architectures for CFD problems.

Pioneering research in computer science at NASA is exploring new computer architectures capable of revolutionary increases in computation rates and the software required to achieve these rates for all major areas of aerospace sciences. Current emphasis is on advanced parallel processing architectures and algorithms. The NASA research is coordinated at the national level with other major programs and is a key element in the new High Performance Computing and Communications (HPCC) Program. The goal of NASA's FY 1992 HPCC Program is to accelerate the development and application of high performance computing technologies to meet NASA's science and engineering requirements. Technology now permits a new generation of massively parallel architectures with the potential of being scaled to the teraFLOPS range by the mid-1990's. In cooperation with other federal agencies, NASA's HPCC will enable teraFLOPS (10^{12} floating point operations per second) computer capabilities essential for computational design of integrated aerospace vehicle systems, for terrestrial environmental modelling capabilities necessary for predicting long-term global change, and for enabling the development of massively parallel techniques for spaceborne applications.

NASA's FY 1992 HPCC Program contains research addressing all four components of the federal program: high-performance computing systems; advanced software technology and algorithms; networks; and basic research. NASA's program is vertically integrated across these components and focuses on NASA's grand challenges in computational aerosciences, earth and space sciences, and remote exploration and experimentation.

In response to the FY 1991 Congressional action, various efforts have been refocused and new activities initiated within the $17 million program. The reprogramming actions required to accomplish this are reflected in NASA's initial FY 1991 operating plan to Congress. Research efforts have been more tightly focused on the development of computational methods for massively parallel computing systems and on modeling of multidisciplinary interactions.

Our fundamental research in fluid dynamics emphasizes the development of accurate and efficient aerodynamic prediction techniques which will lead to major new engineering design tools. Accurate prediction of such quantities as aerodynamic drag requires a fundamental understanding of basic physical phenomena such as flow transition and turbulence. Recently a new turbulence model has been developed and evaluated that more accurately represents the complex vortical flow about a fighter aircraft at high angles-of-attack. In computational algorithm research, there have been promising developments in the treatment of the geometric complexities of complete vehicles, for example, using a triangular mesh for the calculation of flow about a transport aircraft (Figure 10).

In support of **Critical National Facilities**, NASA is committed to support a strong national capability through unique facilities and technical expertise. Paramount to this commitment is our 5-year Wind Tunnel Revitalization Program to restore the health and the productivity of our unique national wind tunnels. This effort is complemented by facility maintenance and instrumentation upgrades to ensure high quality and utility of our future wind tunnel capabilities. FY 1992 is the fourth year of the 5-year Major Wind Tunnel Revitalization Program and design and construction are progressing well. The Hypersonics complex at Langley Research Center and the 10x10-Foot Supersonic Propulsion Tunnel at Lewis Research Center are in the construction phase and are near completion. The site work for the Ames Research Center's 12-Foot Pressurized Wind Tunnel is complete, and the work on the largest construction package, the tunnel shell, has started. The construction phase on six of eight projects initiated in FY 1990 has started with the remaining two to begin soon. All five FY 1991 projects are in final design and construction will begin this fiscal year. Both the wind tunnel revitalization program and our facility maintenance enhancements are essential to ensure that critical national facilities are available for high priority industry, NASA and DoD aeronautical programs.

Leadership in aeronautics is very important to our international balance of trade and national security and to the safety and efficiency of our air transportation infrastructure. In partnership with the industry, the university community and other government agencies, we continue to develop and implement our strategy for maintaining technology leadership and we are making substantial progress. We have reviewed, focused and prioritized our research and technology programs to concentrate on the most critical and timely areas. Our budget request reflects our critical assessment of our highest priority requirements. In FY 1992, we must work those barrier technology issues, including initiation of research on critical advanced materials with long development times that will allow U.S. industry to make timely and informed decisions on high-speed aircraft. Development of long-term solutions to support a healthy and growing National Aviation System, is a national priority requiring the immediate, coordinated efforts of NASA and the FAA. To ensure the long-term health of our aeronautics capabilities, we must continue to pioneer the broad fundamental knowledge and technology base critical to the design of all future advanced aeronautical systems.

This year NASA and its partners in aeronautics paused to reflect on 75 years of innovation and excellence in research and technology and to consider their enormous impact on our nation and the world. However, there is little time to dwell on past accomplishments. Our leadership in aviation is being challenged as never before, by an increasing number of competitors. NASA and the nation must continue to look forward and aggressively pursue pioneering research for high payoff technologies and speed their transfer to industry for development of the high quality, competitive aeronautical products that will keep us the world leader in aviation.

Thank you, Mr. Chairman. That completes my prepared statement. I would be pleased to address any questions you may have.

Office of Aeronautics, Exploration and Technology

R&D Budget
($,M)

	FY 1992
Aeronautics R&T	591.2
R&T Base	375.6
Systems Technology	215.6
High-Performance Computing	(17.0)
Enabling Propulsion Materials	(16.5)
Advanced Subsonic Technology	(5.0)

Figure 1.

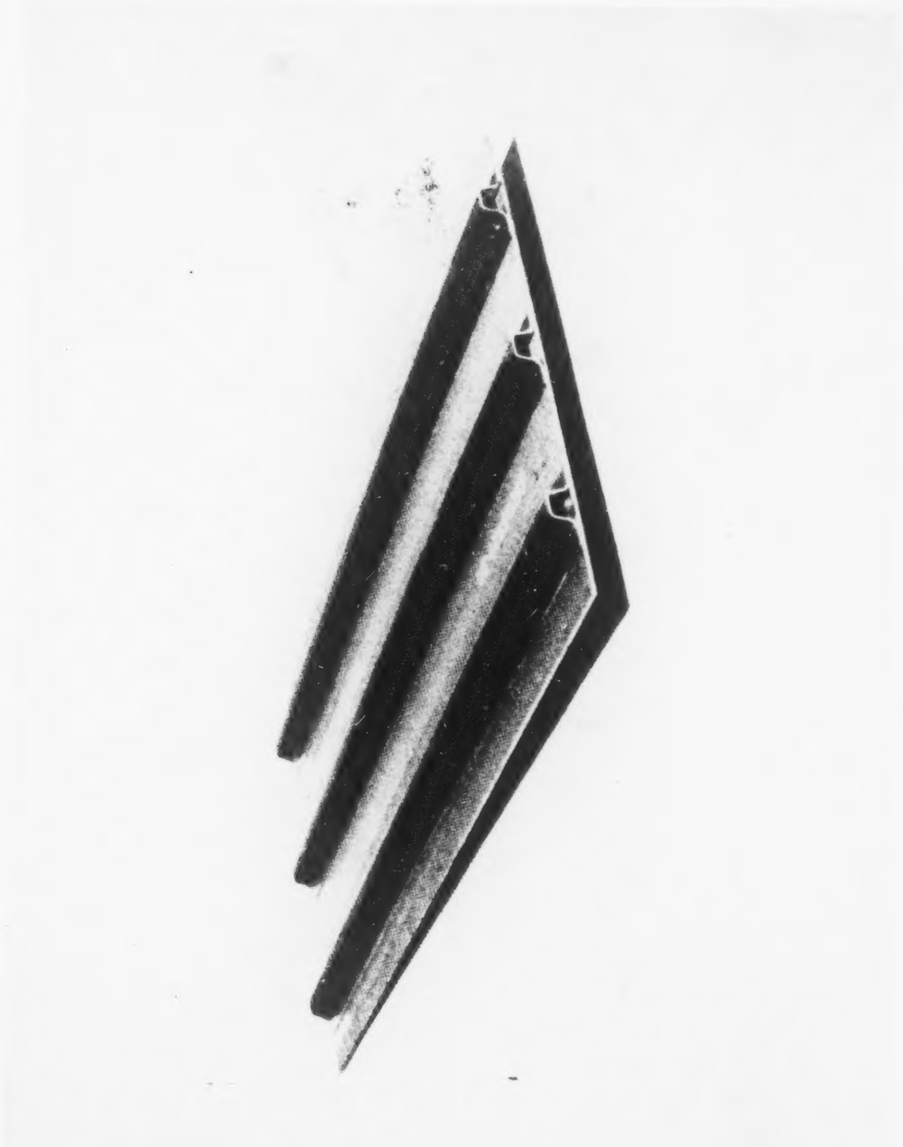


Figure 2. Advanced Fiber Placement Technique Test Panel

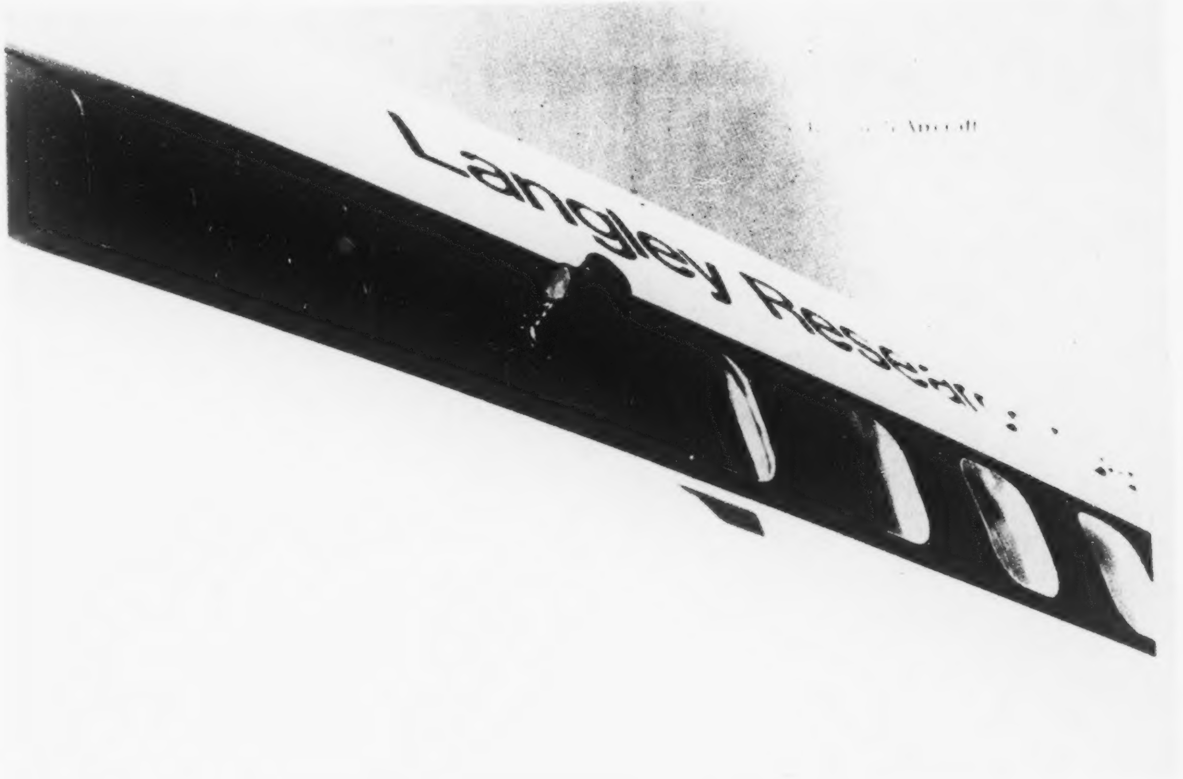

Langley Rese

Figure 3. Infrared Sensor for Microburst Detections Mounted on NASA Research Aircraft

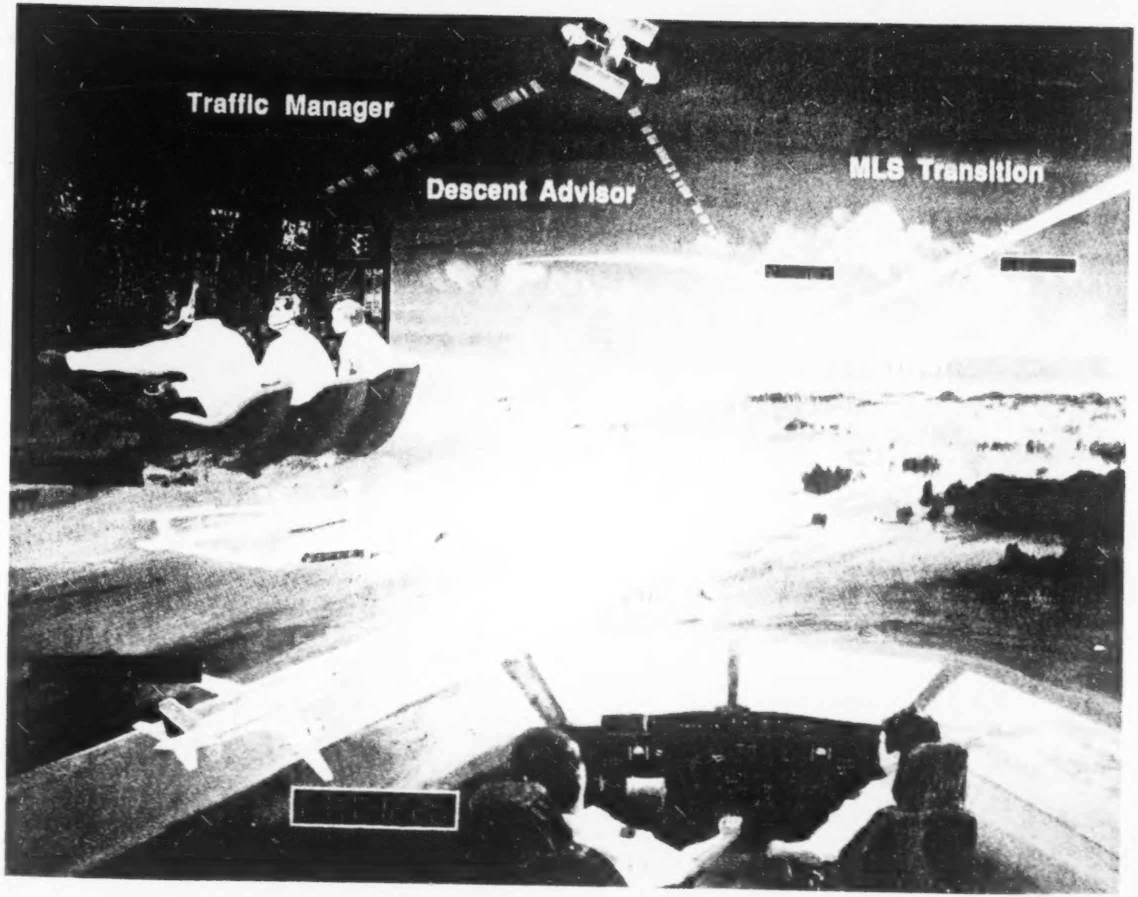

Traffic Manager
Descent Advisor
MLS Transition

Figure 4. ATC Automation Concept Environment

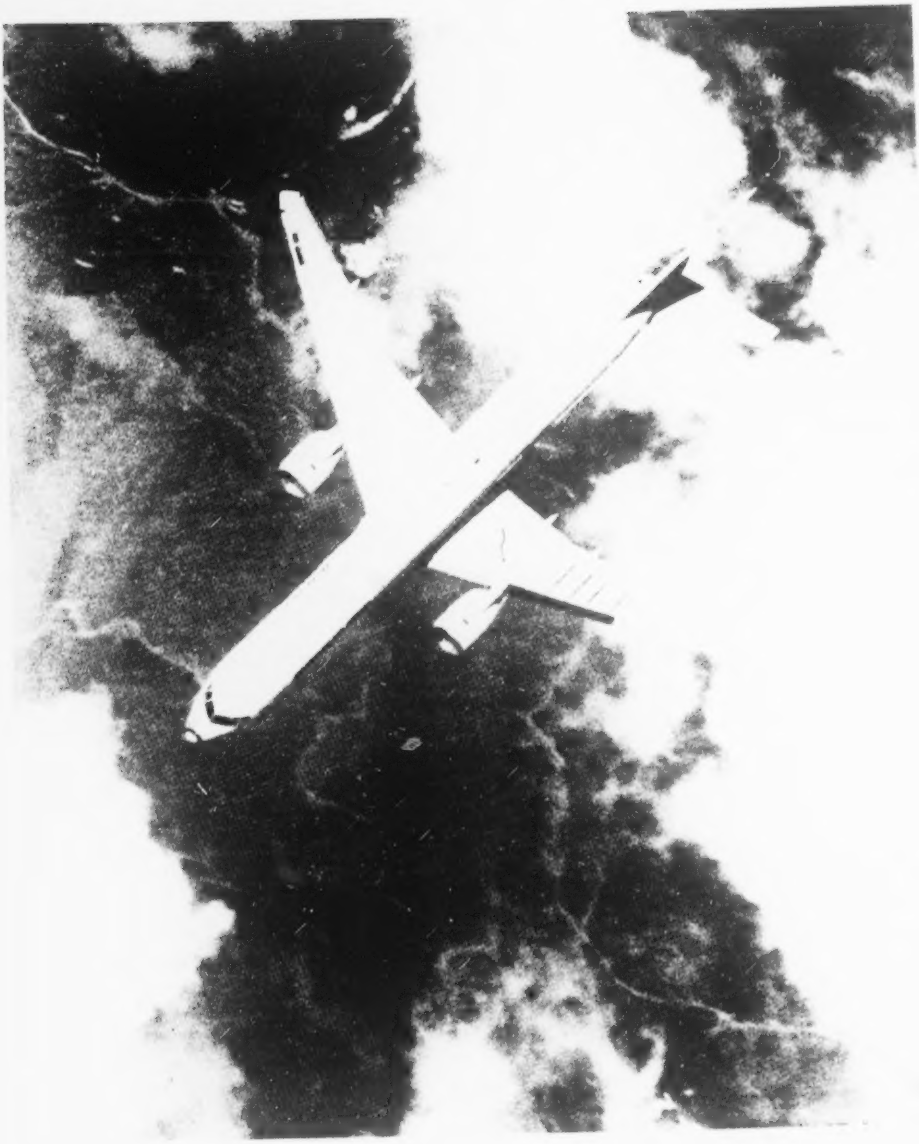


Figure 5. Hybrid Laminar Flow Control Test Panel Mounted on Left Wing of Boeing 757

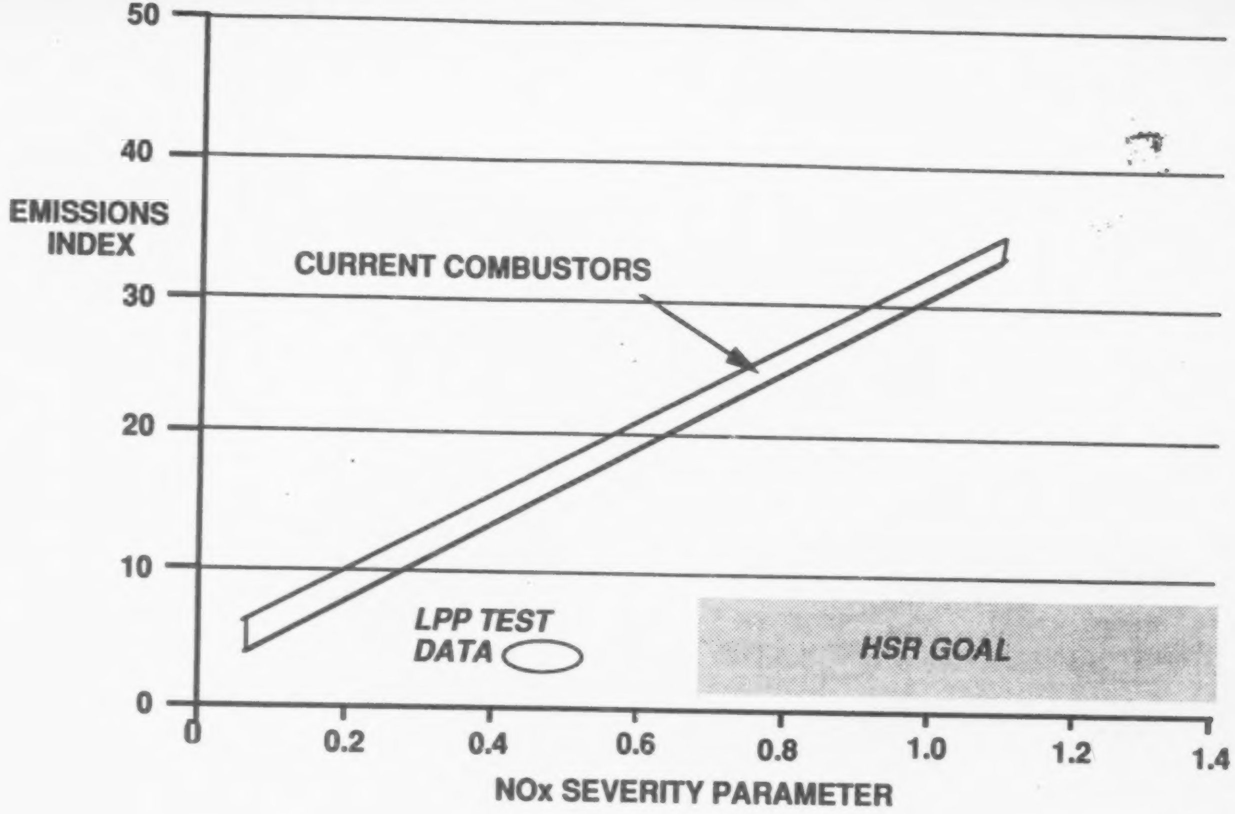


Figure 6. Low Emissions Combustor Concept Flametube Test Results

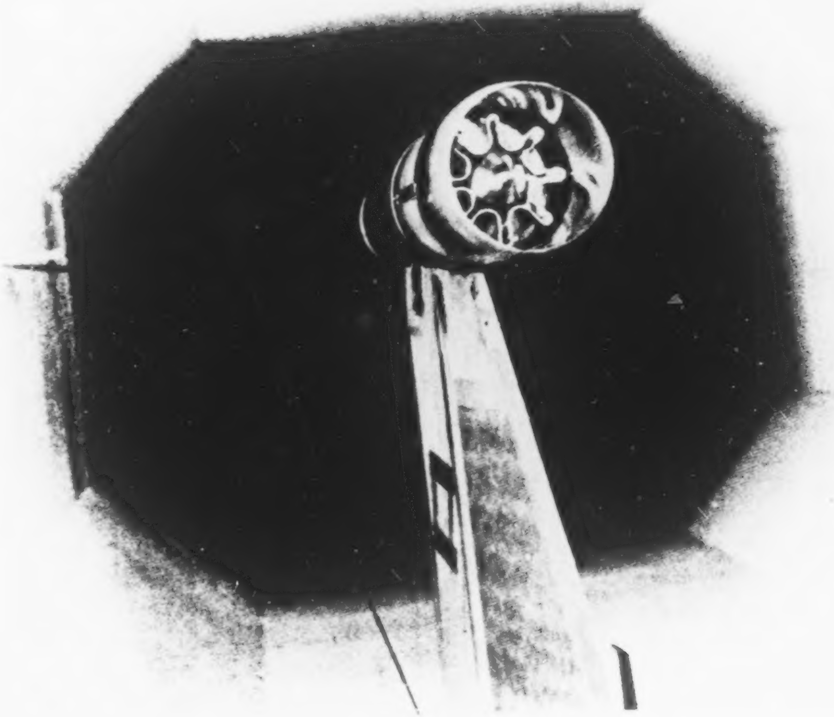


Figure 7. Low Noise Mixer-Ejector Nozzle Model in Acoustic Test Facility

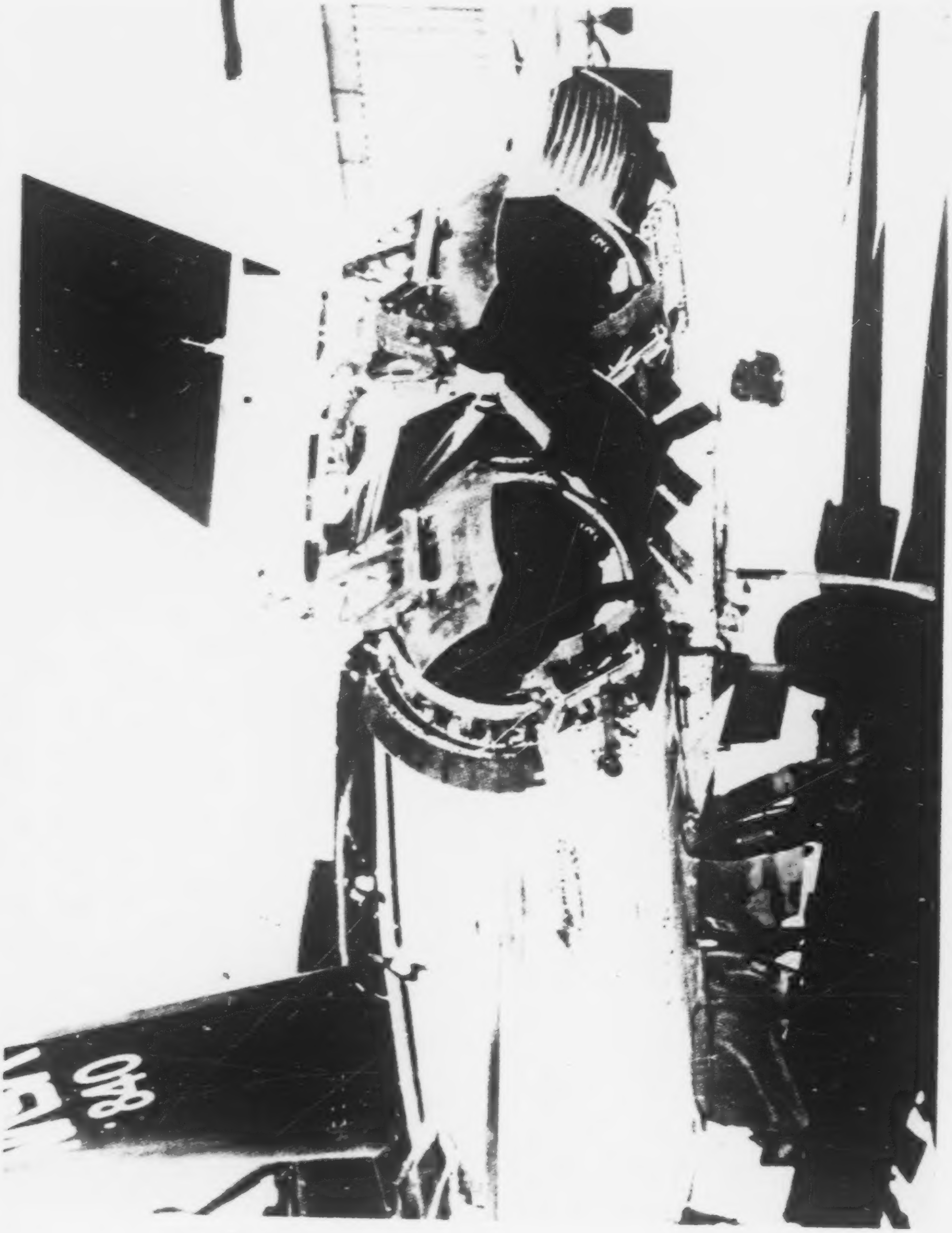
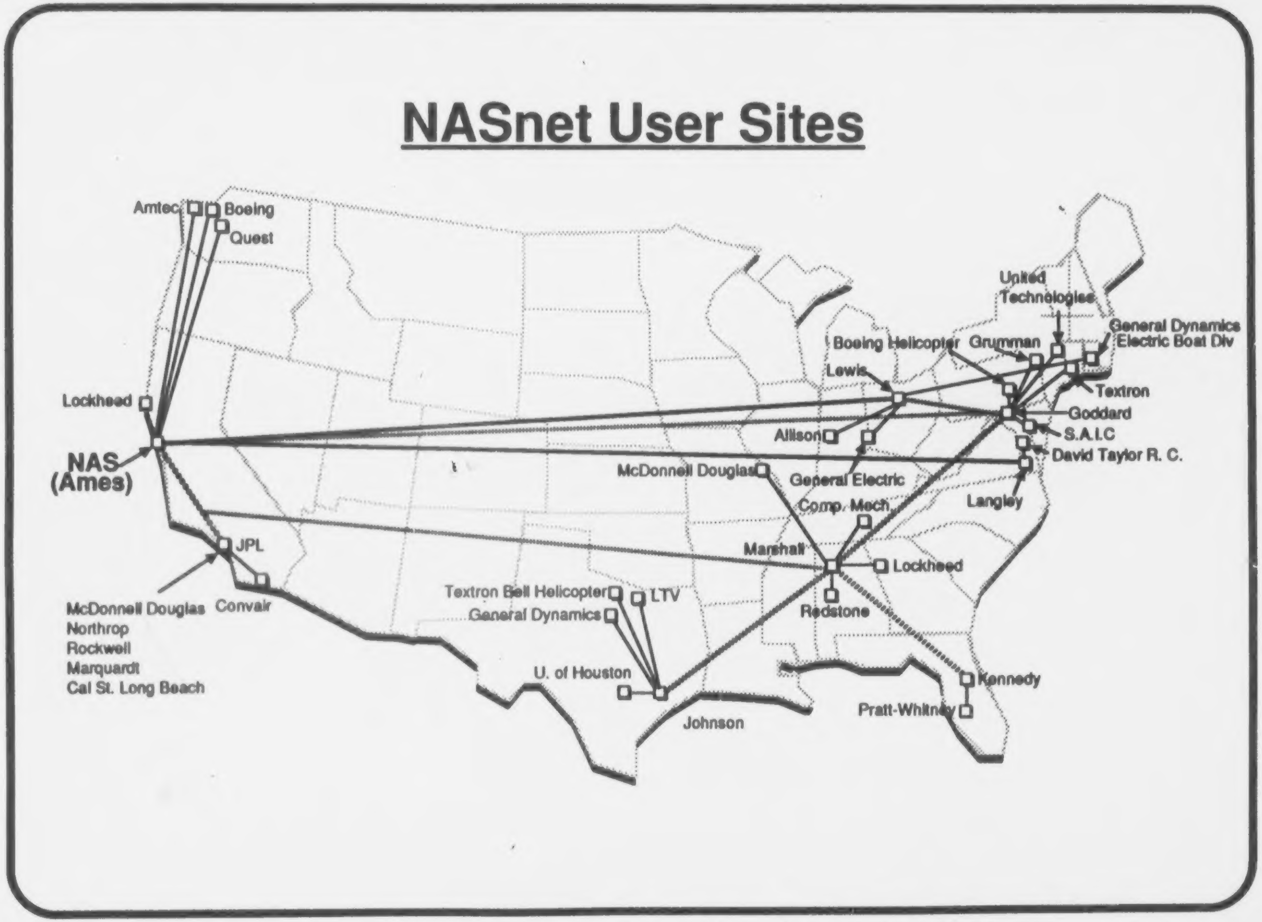


Figure 8. F-18 High Alpha Research Vehicle (HARV) with Thrust Vectoring Control System



NASnet User Sites

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LTV
General Dynamics
U. of Houston
Johnson
McDonnell Douglas
Marshall
Lockheed
Redstone
Kennedy
Pratt-Whitney
Allison
General Electric
Comp. Mech
Lewis
Boeing Helicopter
Grumman
United
Technologies
General Dynamics
Electric Boat Div
Textron
Goddard
S.A.I.C
David Taylor R. C.
Langley

Figure 9. High Speed Communications Network Connections to NAS

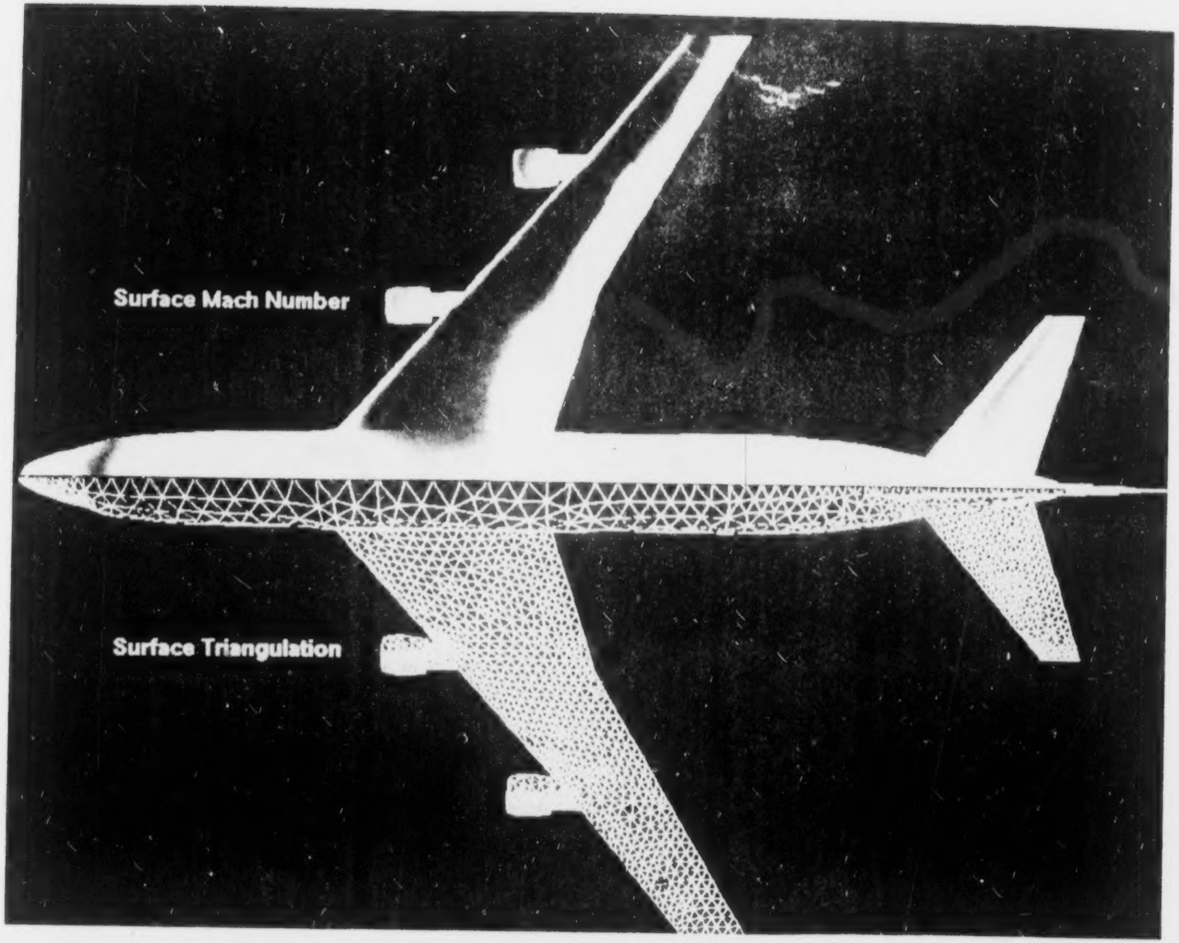
Surface Mach Number
Surface Triangulation

Figure 10. Transport Aircraft Configuration Modeled with Triangular Mesh

Mr. VALENTINE. Thank you, Mr. Aldrich.

I have just a few questions, and maybe what would be classified as a statement.

The situation or perception of the situation that exists between NASA and FAA—I wish you would give us some further explanation of it. It would appear that funding for some of the programs that NASA comes to the Congress and asks for money to operate are areas or programs or procedures that are undertaken in cooperation with the FAA or for the FAA. It appears to some members that these are functions that should be carried out by the FAA, that they should use money that comes in through the Trust Fund, the facility fees and services paid by users.

Can you give us some examples of areas that might concern you and that concern members of Congress, and what, if anything, needs to be done about it? We have that money, it is collected, there have been efforts in Congress and I hope there will be another effort this year, and I hope it will be successful, to allow the FAA to utilize the money that has been paid in in good faith by the citizens of this country.

As to what areas where NASA, in cooperation with the FAA does things that really have nothing to do with the space program, what can you tell us about those things?

Mr. ALDRICH. Mr. Chairman, over the last several years, NASA and FAA have worked intently to increase our cooperation on national problems in our aviation infrastructure. During the last year, we have accelerated that work through six formal committees that have been jointly committed to and staffed by the FAA and NASA. They deal with the areas of human factors, severe weather, environmental problems, cockpit and air traffic control integration, airworthiness and program support.

Mr. VALENTINE. What do you mean by the cockpit integration? Give us a little more detail about that.

Mr. ALDRICH. Integrating the activities that the crew must use in the cockpit and their displays and information with what is available to the ground air traffic control system and their displays and information, and providing for a more integrated system that will allow a more effective and hopefully more efficient utilization of air traffic systems by advances in those systems areas working together.

In working these areas with the FAA, we really serve as a strong technical arm for the FAA in their programs and their area of concern. NASA has a lot of research capability throughout its research centers to work these problems. I think we have worked a very positive program and increased the emphasis in these areas significantly with these agreements and these new programs.

The question you asked about the Trust Fund, however, is not an area I am directly familiar with. The FAA policies and plans and arrangements for the Trust Fund I cannot comment on directly although I believe our program with the FAA and technology is very pertinent and meaningful to our near term aeronautics problems.

Mr. VALENTINE. Well, of course I mentioned the Trust Fund thing because if NASA is, in effect, coming to the aid of the FAA in areas that involve safety issues or the question of the procedural guidance for pilots and that sort of thing, it is an area where, if they were required to use this Trust Fund money, it might help us to get at it.

If they can keep that money piled up over there, as the Administration and some members of Congress want to do, so as to make the budget deficit look better, then go to NASA and get relief on some of these areas, we would just like to have as much information as we can get on places where this sort of thing occurs, so we can use it as a wedge.

When this occurs, is there any arrangement of effort as far as you know, Mr. Aldrich, to require the FAA to compensate NASA for services rendered, as they would a private contractor?

Mr. ALDRICH. I believe our arrangements to date have dealt with us providing NASA-funded technology support to joint program priorities we work out together. Certainly more funds could be applied to these critical problems in a beneficial way, but the arrangement between NASA and the FAA I don't think up to this point has dealt with Trust Fund and FAA direct funding to NASA.

Mr. VALENTINE. I realize aeronautics is very much a part of your name and part of your area of responsibility. If we were to say to you, please give us a list of situations that would fall into the category I am talking about, would that be an unreasonable burden? Are we talking about a lot of different areas? Are we talking about places where it might be difficult even to piece it together?

Mr. ALDRICH. Our research directly supports safety and air system capacity and efficiency. These are both strong technical problems that the FAA is facing. We could well provide you a definition of these. They are the very things our program focuses on.

[NASA has not responded to this request.]

Mr. VALENTINE. All of us know we are moving toward an era of explosive development in hypersonic flight. We know that we are hard pressed to match accomplishments that are taking place in other countries. Of course, we aspire to maintain the position of leadership which we have enjoyed in the past. Do you believe we have the vision and aggression in connection with the hypersonic wind tunnel program and associated facilities to meet the challenge?

Mr. ALDRICH. Over the past several decades, I believe efforts in hypersonics may not have received as much attention as perhaps it is due for our future in this field. However, with the institution of the National Aero-Space Plane Program, in the middle of the last decade, there has been significant emphasis both by NASA and the Department of Defense on hypersonic technology.

That's a subject for another hearing, as you pointed out at the beginning of this meeting. However, I believe the National Aero-Space Plane is one of the most important technology programs going on in the world today. It does directly relate to our needs in hypersonics for the future.

In terms of facilities, the NASP is being executed in such a way that it utilizes DOD facilities and NASA facilities and industry facilities in a fairly effective way today, building toward a flight test program that would define hypersonic vehicle configurations for the future and perhaps also define new facility requirements in the years ahead for operational vehicles.

I believe today we have research facilities that support NASP quite well. Within NASA we are building several operational facilities at the Dryden Flight Research Facility to support the flight test phase of the NASP program. So today I think we are facilitated to move our program forward and in the future I think we will likely identify new facility requirements as well as vehicle requirements directly out of the NASP hypersonic program.

Mr. **Valentine**. Back briefly to the FAA arrangement in the Trust Fund, the Trust Fund has a balance of somewhere around $16 billion. After some allocations, perhaps a balance of around $9 billion dollars has been collected from taxpayers and users. It is just there in a big pile. As I said, I don't want to add to your burden, and I don't want to, by these statements, wander into an area and find out there is a crate of material over here that is prepared as a result of this.

But if you can, reasonably, Mr. Aldrich, confer with staff members so we can begin to get information as to these areas where we might go to FAA and say "Listen, you do this yourself, or if you are going to ask NASA to do it, you compensate NASA out of this Trust Fund so we will not be adding that extra tax burden to taxpayers unnecessarily."

We have been joined by other members, and as is the policy of the subcommittee to recognize members not on seniority, God bless us, but based on the time they appear at the hearing—those are my orders, so to speak, from the big chairman, if anybody has any questions about it.

Mr. Roemer, do you have an opening statement or any questions?

Mr. **Roemer**. Thank you, Mr. Chairman. I do not have a formal opening statement other than to say that again we are pressed for time around here, and I have to run off to a hearing on civil rights. But the testimony I did hear, I was very impressed with your presentation and the facts contained in there. I am very impressed with the trade balance we have been able to attain from the industry.

I have a couple of specific questions. One, as it regards the DARPA program, and the NASA cooperation with DARPA, the DARPA program is one I worked fairly closely with on the Senate side. If you could address how closely you are working now, and where you see that relationship going, to enhance especially the commercial application and the trade balance in the future.

Mr. **Aldrich**. In the past, NASA has worked cooperatively with DARPA in a number of technology programs. Today, in fact, one of the most direct couples with DARPA in our aeronautics program is computing. DARPA and NASA have two of the largest shares of the new National High Speed Computing and Communications program. We expect a tight couple there in the next few years.

In flight research, today we are negotiating with DARPA regarding their program for the X-31 high-angle-of-attack flight research vehicle that they have been flying with industry, and bringing NASA and the Dryden facility directly into that program. So we have a number of specific program areas. We don't have a tight couple in a wide range of technology in the current time frame.

Mr. **Roemer**. My second question is in terms of the openings and changes we have seen in the Soviet Union, what is your personal assessment there of their ability to develop new technologies in this area, aeronautics, and in other areas? We have been seeing all different kinds of varying analyses from the Defense Department and the CIA and the DIA. How would you look at the future, specifically the next 10 years, in the Soviet's development of commercial technologies here and in aeronautics?

Mr. **Aldrich**. During 1990, we had an exchange of visits with senior people from the aeronautics technology industry in the Soviet Union and also from our Government laboratories here at NASA. Dr. Rosen, who is with me, was the senior NASA lead for both the visits in the Soviet Union and here. I would like for him to give you his assessment of an answer to your question.

Dr. **Robert Rosen**. We spent about a week touring the research laboratories associated with the Ministry of Aviation Industries in the Soviet Union. Then their research directors came and toured our laboratories.

Frankly, we were very impressed by what we saw. The nature of the work they perform is first-class, it is world quality work. In particular, their fundamental use of mathematics, their fundamental algorithms, are about as good as ours are in this country. So there is a very, very strong technical capability that exists in the Soviet Union. In certain areas, they are on a par with the United States.

Now, there are a lot of areas where they are not, in particular, in the air-breathing engines. They do not have the same capability that we have, and they clearly do not have the same kind of manufacturing capability that exists in this country. But on a fundamental technical level, I think there is a lot we can learn from the Soviets.

Mr. **Roemer**. Right now on PBS there is an ongoing special on the development of the Soviet space program. One of the things they have said in this program, they have talked about the Soviets' inability to translate their space program into commercial success. Where are we in comparison to the Soviets? I have seen some of the fascinating statistics— the ratio of dollars spent on NASA and how it translates, for every $1 spent, $10 is then translated into commercial application—how is that now?

Dr. **Robert Rosen**. We have done a study recently that shows that those same economic factors still hold. In fact, it is something like ten to one. The monies that go into NASA programs eventually spin off into industrial products. The Soviets, as I said, have an awful lot to learn, with respect to taking their excellent fundamental work and turning it into high quality products. If you ever have the opportunity to go to the Soviet Union, you will see what I mean. Their economy and their standard of living is a lot different than ours.

On the other hand, I think they do have some very good fundamental work. Our plan is to see if there is something we can learn from them in the fundamental areas, and not teach them anything in the product areas.

Mr. **Roemer**. Thank you. Thank you, Mr. Chairman.

Mr. **Valentine**. Thank you. Mr. Rohrabacher?

Mr. **Rohrabacher**. Thank you, Mr. Chairman. Dr. Rosen, I hope that indeed we do start learning some things from the Soviet

Union. They have been stealing enough from us over the years. It seems every time we look at some of their weapons systems, they seem to have the same design our weapons systems have. For some reason, I tend to think they did not put the same amount of money into the research and development that we did.

Could you comment on that?

Dr. **Robert Rosen**. I have seen pictures, Mr. Rohrabacher, but I do not have any detailed knowledge, other than what I see in magazines.

Mr. **Rohrabacher**. Do you believe that the Soviet Union, over the years, has benefitted from American research and development by the fact that they were able to in some way get their hands on some of America's technological—I hate to say secrets, because I am not just talking about espionage, I am talking about perhaps pure stupidity on our part?

Dr. **Robert Rosen**. I would rather not comment on pure stupidity, Mr. Rohrabacher. I think that for many years the United States was clearly the world leader in technology. Quite some time ago, we probably did not pay as much attention to protecting that as we should have.

But that situation has changed dramatically with respect to how we are concerned about technology transfer. Certainly the three of us sitting at this table are very concerned that no technology goes overseas that will benefit our foreign competitors at the disadvantage of the United States. We are very concerned about that. One thing we do not want to do is have the taxpayer dollars that come to NASA somehow help the French or the Japanese or the Soviets.

Mr. **Rohrabacher**. Thank you very much.

Mr. **Aldrich**. Mr. Rohrabacher, could I comment on that as well?

Mr. **Rohrabacher**. Yes, sir.

Mr. **Aldrich**. I spent a long time working on the space shuttle. Your thoughts come directly to me when I look at the Soviet shuttle and see it in comparison to the American shuttle, being almost identically the same aerodynamic vehicle. But our shuttle technology is civil technology, and it is available in the public literature and it is not protected by our Government in any particular way.

We are not able, in our current national environment, to totally protect that. The mechanisms we hope to employ in the future are to give our industry the kind of lead time it needs to get those technologies into place first, which happened with the shuttle. But it is difficult to protect them in the long term.

Mr. **Rohrabacher**. I am sure that the similarities between the Soviet shuttle and the American shuttle are merely coincidental, as has been the coincidental comparison between, for example, their submarines that just happen to have the same number of missile tubes ours do, and almost exactly the same configuration.

But we are on the edge. I happen to believe that America and mankind is still on the edge of the Pacific Era. There has been a lot of attention given to the Soviet Union and a lot of attention given to Europe and Eastern Europe in the last few years. But I think when everything shakes down that we are still going to find that the thrust upward that mankind is making will be found in the enterprise and commerce along the Pacific Rim.

Mr. Aldrich, I was very happy that you mentioned and actually underscored hypersonics in your testimony. Do you think there would be—do you agree that the development of hypersonics is probably, when you consider the potential of the Pacific Rim, is going to play a major role in commerce and aerospace in the years ahead?

Mr. **Aldrich**. We see two classes of vehicles. In the near-term years ahead, the next 15 to 20 years, we see high- speed civil transports in the supersonic range being the great competitors for the market and likely the vehicles that will capture that market. Our goal is to keep the United States in the lead in that field.

Downstream of that, we see hypersonic vehicles in the longer term which will be perhaps the third generation of high-speed vehicle, particularly our NASP technologies work directly on that class of vehicle. But that's a little bit longer horizon. The competitive advantage is not as clear at this point.

Mr. **Rohrabacher**. If you had to bet on which country will dominate the aerospace industry in the world in both of those next phases that you talked about, where would you put your money?

Mr. **Aldrich**. Dominate is a strong word. Currently Boeing is starting a new vehicle called a 777. Boeing is the manufacturer in the lead, but it is now having much of its components and parts and substructure made overseas by other nations. I think the impetus for international teaming will continue based on the drives of the marketplace.

I believe the United States can have the lead and should have the lead and that should be our goal. But how dominant we are will be partly as a result of our technology efforts, and partly from the kind of teaming and sharing that makes fiscal and economic sense in the marketplace.

Mr. **Rohrabacher**. If I could ask one more question, Mr. Chairman, I would appreciate the indulgence of the chair.

Mr. **Valentine**. You could have asked your question in the time it takes to get permission.

Mr. **Rohrabacher**. Yes, sir.

Do you believe that the FSX fighter deal and other such deals we are making with the Japanese are aiding them, or assisting them, in developing an industrial base that will be used to compete against the United States in a new era of high-speed aircraft?

Mr. **Aldrich**. Bob will answer that.

Dr. **Robert Rosen**. Mr. Rohrabacher, I think the FSX deal is a really complex deal. I think those kinds of questions more rightly should be asked of the Department of Commerce and the Department of Defense.

But let me answer a little bit. It is clear that there will be some ability of the Japanese to do something in the future they could not do in the past. But I think you really have to trade off with that improvement in their capability the improvement that comes to the United States. A decision was made that all things considered, the benefit would be to the United States in terms of dollars and jobs. The decision the Administration made was to go ahead with the FSX.

Mr. **Rohrabacher**. I believe you are right, they did believe the profit would be better for the United States, probably better for at least a year, while the major corporations made their profit for that year. Probably 10 years later, when all the executives who made that decision, the next generation of executives might have a different view of how profitable it is.

Thank you very much.

Mr. **Valentine**. Thank you, sir. Mr. Bacchus?

Mr. **Bacchus**. Thank you, Mr. Chairman.

For the record, I believe the FSX deal was a grievous mistake. I applaud your diplomacy, Dr. Rosen, in your answer. I do intend to ask some of the people at Commerce about it, as time goes on.

I am concerned about our technological base in the United States and our ability to manifest our interests as a country in the future. I am sure you are as well. I am very much aware of the important role that aeronautics research has played in achieving advantages for our trade balance. I am aware that we continue to have the world's share in that particular market. I am also aware that that share we have is declining. I am concerned about that, as I believe each of you gentlemen is as well.

Looking at the aftermath of the Persian Gulf conflict, we are all rightly relieved that casualties were so low, we are celebrating our victory in the Persian Gulf. One of my concerns is that celebration may turn into complacency. We have all heard so much on the television in the many post mortems about the superiority of American technology.

There was an article on the front page of the New York Times on Sunday, that you may have seen, that tried to examine some of those assertions. It reinforced in my own mind my apprehensions that as Americans we may now go from having an inferiority complex about our technology all the way over to having a false sense of security about our technology. I believe we have good technology and good technology research in this country. I also believe we are facing some very real competition in the world.

There were several assertions made in that article that I would like to ask Dr. Aldrich to reflect on, based on his background and his own perspectives, as someone who is very much involved in the technology field. You mentioned in the course of your testimony about foreign competition that we increasingly face around the world. You mentioned the fact that we now have the oldest civilian fleet we have ever had. Dr. Rosen has talked about the competition we are seeing from the Soviets, among others.

One of the assertions made in that New York Times article was that while the smart bombs and all the Nintendo warfare we saw was very impressive, the truth is that much of the technology in these weapons is really more than a decade old. In many instances, a lot of the things we see and use every day, in terms of home computers, are much more advanced that some of that weaponry, which was actually designed some time back. Is that just a journalistic assertion, or is there truth in that, Mr. Aldrich?

Mr. **Aldrich**. I have a strong opinion that the technology that is in the field today and that we witnessed in that conflict definitely is technology that has 10 years of maturity in order for it to be in the field and be used operationally. Investments for that technology were made prior to that time. We need to be investing today in the technologies of the 1990s so that we can have the kind of future systems we will need in the years ahead.

Mr. BACCHUS. A second, and related, question. One of the other assertions we have made in this article was that in the case of many of these weapons, the various components were actually made by foreign countries, and that in many instances, these were among the most sophisticated components. Do you have any thoughts on that? Is that accurate?

Mr. ALDRICH. Yes, particularly in the electronics industry. Some of the most sophisticated and desirable parts are not available either at all, or in the quantities needed in the United States because of the competition from overseas and because of their ability to capture that market.

Mr. BACCHUS. Is this something that concerns you in your own research for NASA?

Mr. ALDRICH. It concerns me to a degree. We have the ability to create those products. We don't intend to create the market to produce them economically.

Mr. BACCHUS. We have talked a little bit about DARPA and the relationship between what you do and what the Defense Department has done. One of my concerns has been that an increasing share of our overall research and development budget has gone to defense. I happen to believe that we need to put a lot of research and development into our defense. I also happen to believe we should make that research and development pie larger and get more overall.

But while the pie remains as small as it is, I believe 70 percent of our overall R&D budget may be going to defense, and a smaller portion to civilian purposes, one of the things that is clear, not only from your testimony but from the supporting testimony I have seen that we will hear, is that the civilian aerospace industry depends immeasurably on NASA and your research for its hopes to advance. Can you comment on that?

Mr. ALDRICH. I agree with your thrust in that question. One of my other jobs is space technology for NASA, and we have recently had the Norm Augustine Report on the assessment of the NASA program. One of the findings is that our space technology budget is significantly underfunded, and it is also underfunded in the areas that directly support commercial activity.

We are working hard this year to build the space technology budget based on those findings and also our own conclusions and opinions in the past. In aeronautics, we have been gradually building our budget over the last several years. Next year when we come forward, we hope to be providing a request for additional increases in some of the areas we are talking about here this morning that are very important, the high-speed research and also the National Aero- Space Plane.

Mr. BACCHUS. Thank you very much, Mr. Aldrich. Thank you, Mr. Chairman.

Mr. VALENTINE. Thank you. Mr. Lewis?

Mr. LEWIS. Thank you, Mr. Chairman. Mr. Chairman, I have an opening statement, and would like to ask unanimous consent to place that into the record?

Mr. VALENTINE. Without objection.

Mr. **Lewis**. I apologize, I had to go to another subcommittee first this morning.

Mr. Aldrich, I would like to ask you a couple of questions. As our scientific people have indicated, we cannot keep research results and technology advancements from other nations for more than say, two years. Do you feel NASA's programs should be strengthened in the area of aviation technology, and if so, how would you do that and would this also include the Freedom of Information Act?

Mr. **Aldrich**. We of course work daily to strengthen our aeronautics program, both in what we advocate and how we execute it. Over the last several years we have been very concerned with the technology we do in this country, in NASA and with our industry and with our other agency partners, being available overseas. Because it is civil technology.

We pursued ways to alter the Freedom of Information Act in this regard, and it is a very complex, inter-agency set of engagements, and I think progress has not been far-reaching. Today we are looking at other arrangements in terms of NASA contracting, by contracting in such a way that we leave the technology with the industry rather than bringing it in and making the Government the recipient of that technology. Therefore it is not subject to this kind of open disclosure.

We have a couple of trial issues in that area already underway. It appears promising that this might be a way to help significantly in this regard.

Mr. **Lewis**. In regard to that question, do you have R&D in high-speed civil transportation that you are currently studying? Two major problems arise, with the sonic boom and with the environment, ozone damage. There is a possibility that this may keep the Mach 2 or Mach 3 aircraft or transports from being accepted by citizens of this country in particular.

Recently GE and Pratt & Whitney announced a joint effort with Japan in high-speed civil transportation R&D. Are you concerned about any technology transfers or leakage and the results of noise and ozone damage?

Mr. **Aldrich**. We have worked closely with Pratt & Whitney and GE to understand their participation with the Japanese industry. In fact, their participation was approved both by the Department of Commerce and the Department of State. The GE participation is an assessment of engine designs and the Pratt & Whitney participation is directly with Ramjets.

Neither of those relate in a direct way to the kind of environmental concerns we feel are a high priority. We think their involvement as it has been contracted does not, in fact, directly threaten the initiatives and the technology leads we are working on in that area. This will require careful and close scrutiny in the future.

Both GE and Pratt & Whitney are very much aware of the sensitivity of technology transfer, and I believe will be able to say on top of threats in that regard yet perhaps benefit in some other way from their involvement in the program. Japan also is cooperating with Rolls Royce and SNECMA from Europe, as well as our two industrial firms.

Mr. **Lewis**. One of your fastest growing programs in NASA is human factors. Human error is one of the leading causes of airplane crashes. What are your 1992 plans for studying the causes of human errors and ways to reduce human errors? Adding to that, how are you working with FAA in that area?

Mr. **Aldrich**. I believe it was in 1988 that Congress directed us to specifically address aviation human factors as a national issue, us being FAA and NASA, with FAA being the lead. Since that time, as I mentioned at the beginning of my testimony, we have worked a number of specific new memoranda of agreement with the FAA on detailed areas. One of them is in aviation human factors.

There has been a national plan for aviation human factors put together by FAA with industry and NASA participation. We had a major conference this winter here in the Washington area to review the progress in that regard.

We think it is a positive plan. It addresses the issues that need to be addressed, and it sets the stage for our work in the next several years to focus additional work and research on highlighting aviation human factors as a critical element in our overall aviation safety program.

Mr. **Lewis**. I have one final question. Many of us are concerned about the declination of science and engineering and computer technology students in our academic system and also we are concerned about the dropoff and reduction of instructors in those areas.

Do you have any studies going on at this time about how to pick up in this area, in order to entice various academia, making transfers into science and mathematics and engineering and computer technology? Are you looking at any of this with a concern as to what will happen down the road?

Mr. **Aldrich**. Education is one of the primary thrusts of Admiral Truly's view of NASA's responsibilities and roles. I believe he talked about that in his hearing several weeks ago. Within my organization, particularly in my space organization and the space exploration initiative, we feel that is a major focus that can be applied not only to education, but to university involvement in NASA research and NASA programs. We have a number of thrusts in our space technology in that regard.

In computation and aeroscience, we also have education initiatives. However, they are not quite as prominent in the growing of a new program as it is on the space side today.

Mr. **Lewis**. Thank you.

Mr. **Valentine**. Thank you, Mr. Lewis.

Dr. Thornton?

Mr. **Thornton**. Thank you, Mr. Chairman.

I have just a few questions. I have read your testimony and I appreciate it. It appears to me you have a well thought-out plan for addressing issues ranging from materials, which I think is a most important area of investigation, new methods of control, and of course safety considerations.

My first question concerns safety. The problems of detection and avoidance of microbursts and wind shear is a nightmare to pilots, not only pilots in planes which are equipped with equipment suitable for this, but entering an airfield environment where you are recording wind shears can be a very threatening thing to a general aviation pilot.

Can you tell me what progress you are making in this area?

Mr. ALDRICH. Wind shear is one of the areas of specific emphasis we have with the FAA. We have a technology program specifically addressing airborne detection of impending microbursts. We are looking at microwave systems, laser systems and infrared systems. Within the last few months, we have had a successful demonstration of an airborne infrared detection of a microburst in a real environment.

So we believe significant progress is underway there, and we are in fact going to be able to solve the problem of information directly on board available to the crew regarding the environment ahead of them on approach.

Mr. THORNTON. Well, of course, that's true of the commercial aircraft. The private pilot must depend upon some system on the ground, I suppose?

Mr. ALDRICH. The ground has had systems with varying degrees of effectiveness and varying degrees of availability and deployment. To my knowledge, we are not working on ground technologies as we are the airborne technologies.

Mr. THORNTON. That gets to the thrust of the second part of my question, and I am very much in support of the high technology development of commercial air traffic and the advances that you are outlining. But I am also concerned about general aviation, which continues to play an important role in this country.

I happen to own an aircraft that has an IO5-40. It is a good one, it uses leaded fuels. Should I sell the airplane in anticipation of not being able to buy fuel for it? Are you doing anything to protect general aviation pilots against the advent of being required to use engines that can operate on non-leaded fuel?

Mr. ALDRICH. My understanding today is that many general aviation equipments require leaded fuel. The engines that are available for them are of that class. We have been working engine technology. One class of engine technology we have been working on is the rotary engine, which could in fact, with appropriate development and commercial application, be an engine in the class that could fit general aviation and could substitute for the engines of today's fleet. There is not a direct couple, though, between this engine and a market approach downstream to actually make it a certified commercially available product.

Mr. THORNTON. My question is whether there is any consideration being given to phasing in this engine technology so that pilots who are using King Airs and Beech Barons and other fine aircraft might have a way of continuing to provide the services that general aviation provides?

Mr. ALDRICH. We have been pursuing the technology for such an engine. It is still in the developmental phase. Future plans of its marketability and its ability to phase in would be downstream. It would really be beyond the NASA research effort.

Mr. THORNTON. I appreciate the answer. I guess the conclusion is that if the laws prevent the combustion of non- leaded fuels before that technology is available, we ground our general aviation fleet. Is that right?

Mr. ALDRICH. There may be some other answer or solution that is not apparent to me, sitting here. But that is the program we have worked on that might have some solutions.

Mr. THORNTON. Thank you very much. I yield back the balance of my time, Mr. Chairman.

Mr. VALENTINE. Thank you. I believe Ms. Collins has left, so I believe that gives all the members of the subcommittee who are present an opportunity to question the panel.

Thank you, gentlemen, very much for the preparation that went into this appearance and for sharing this information with us. We would appreciate it, Mr. Aldrich, if you supply us with information on the question I asked you about, if that is not too much of a chore.

Thank you all very much.

Mr. ALDRICH. Thank you, Mr. Chairman.

Mr. VALENTINE. Our next witness is Dr. Ronald E. York, Director, Advanced Engine Products, Allison Gas Turbine Division, General Motors Corporation, and American Institute for Aeronautics and Astronautics.

Dr. York, we welcome you here. As I stated before the other witnesses began their presentation, your statement will appear in the record as presented to us. We would appreciate it if you will summarize, and not longer than five minutes, if you please.

STATEMENT OF DR. RONALD YORK, DIRECTOR, ADVANCED ENGINE PRODUCTS, ALLISON GAS TURBINE DIVISION, GENERAL MOTORS CORPORATION, AND AMERICAN INSTITUTE FOR AERONAUTICS AND ASTRONAUTICS; ACCOMPANIED BY: BRADFORD E. BIEGON, DEPUTY DIRECTOR, SCIENCE AND TECHNOLOGY POLICY, AMERICAN INSTITUTE FOR AERONAUTICS AND ASTRONAUTICS

Dr. YORK. Thank you, Mr. Chairman. It is a distinct pleasure to be here this morning as a representative of the American Institute of Aeronautics and Astronautics, as you consider the impact that NASA's aeronautics research and technology can have on the competitiveness of our aeronautics industry.

Our aeronautics industry continues to be one of the bulwarks of economic and military strength of the United States. In the last few weeks, as you mentioned earlier, the entire world has witnessed the importance of possessing a technological advantage in aeronautical weapon systems, as our very well-trained and equipped fighting forces devastated the fourth-largest military power in the world in a relatively short time and with minimal losses.

In the economic arena, it is equally important to have a well-trained and equipped work force and technically superior products, as we compete in a world market full of competitors which have targeted the aeronautics industry as a key objective as part of their national strategy.

Aeronautics is truly one of those dual use technologies which brings major benefits to both the civilian economy and the national defense. The United States aeronautics industry estimates sales of $113 billion for 1990, which includes the generation of a record $26 billion in favorable foreign trade balance, posting the sixth consecutive record, and another one anticipated for 1991.

Against this general backdrop of our concerns about the competitiveness of the U.S. industry and our falling exports, even in several technology-intensive industries, the continued strength of the U.S. aeronautics industry stands out as an example of the benefits which can result from a long-term constructive relationship between government, industry and academia.

Since 1915, the United States' national policy has called for leadership in aeronautics. This goal has recently been reaffirmed by the President's Office of Science and Technology policy. Historically, the lead role for advancing aeronautics technology was given to NACA, and subsequently to NASA. In conjunction with other government agencies, industry, and our universities, NASA's research has led to many significant aeronautics discoveries and pioneered the demonstration of advanced aeronautics technologies. These have found their way into advanced civil and military aircraft, which serve our Nation and the world today.

We would like to commend Congress also for their role in supporting this goal of world leadership in aeronautics, and for providing the funds necessary to ensure that we achieve this goal. The 45,000 members of AIAA are members of this team, and we are also proud of the contributions we continue to make to the United States economic and technological strength.

However, even with all these favorable results, there is cause for concern. Although the United States industry sales are at a record high, our total world market share continues to erode in key aeronautics sectors. While exports and trade balances increase, imports are also rising, as foreign products penetrate the sub-tiers of the aeronautics industry.

The importance of these trends is that they are evidence of the success of other nations' dedicated efforts to build up their own aeronautics industry, often with direct support that is incompatible with our free market policies. Unless effectively countered, these unfavorable trends show no sign of abating, and could lead to the United States becoming a net importer of aeronautics products.

The United States does not possess the advantage of low cost of capital or low cost of labor, so our continued success in the world marketplace depends very directly on our ability to provide technologically superior products to a sophisticated customer who can translate that advantage into profits.

The United States aeronautics industry will continue to look to NASA as it has in the past, as the primary source of advanced aeronautics concepts and proven technology that can be further developed and applied to create these U.S. aircraft engines and associated products, which can compete successfully in an increasingly competitive world market.

For this reason, the AIAA strongly supports NASA's aeronautics research and technology program, and wishes to encourage this committee's support, as well, through the budget authorization process. The Administration has proposed a fiscal year 1992 budget of just over $1 billion for NASA's aeronautics-related efforts, which includes an increase of 12 percent in the research and technology area, and 20 percent in systems technology programs. The aeronautics policy committee of AIAA had an opportunity to review recent accomplishments in these areas and the proposed technical efforts that would be accomplished with these budgets, if they are approved by Congress. We endorse the overall program proposed by NASA.

In particular, we are pleased to see the increasing emphasis given to systems technology, because of the critical role technology validation plays in transitioning the results of research into technology that industry can then apply into a new class of products.

Thank you, Mr. Chairman.

[The prepared statement of Dr. York follows:]

Statement

to the

Subcommittee on Technology and Competitiveness
Committee on Science, Space, and Technology
United States House of Representatives
March 5, 1991

of

Ronald York, Ph. D.
Chairman,
Aeronautics Policy Subcommittee
American Institute of Aeronautics and Astronautics

Statement
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Ronald York, Ph. D.
American Institute of Aeronautics and Astronautics

Mr. Chairman and Members of the Subcommittee;

The American Institute of Aeronautics and Astronautics (AIAA) wishes to commend the Chairman of the United States House of Representatives' Committee on Science, Space, and Technology for reorganizing the committee and establishing this subcommittee on Technology and Competitiveness. As we enter a new era of world peace, we recognize that the United States must now turn its attention to a new challenge – that of the competitiveness of the United States' enterprise system. More than at any time before, we recognize that our future national security, and the other benefits of our society, depend on our economic strength. It is most appropriate that the United States Congress devote the agenda of this committee to technology and competitiveness.

Aeronautics has long been one of the strongest sectors of our industry. The Department of Commerce estimates aerospace will record $113 billion in total sales for 1990 and a favorable trade balance in excess of $26 billion. Aeronautical products (aircraft, engines, missiles and related parts) dominate these sales. The continuing success of our aeronautics industry is due, in large part, to the long–term, constructive relationship that has existed in this area between government, industry, and academia. Congress has been an important part of this relationship by authorizing the funds necessary to build and maintain our aeronautics technology base.

The 44,000 professional and student members of the American Institute of Aeronautics and Astronautics (AIAA) are proud of the contributions they make to the United States' economic and technological strength. As the nation's leading aerospace professional society, the AIAA is dedicated to the promotion of the arts, sciences, and technology of aeronautics and astronautics. To foster the advancement of the profession, AIAA sponsors numerous technical conferences, workshops, and symposia that steadily advance the frontiers of aerospace knowledge. In addition, the AIAA has published over two hundred scientific and technical books ranging from the popular *Augustine's Laws* to our latest book, *Introduction to Mathematical*

Methods in Defense Analysis. The AIAA also publishes six technical journals and its members' magazine, *Aerospace America*. AIAA maintains an on-line network of aerospace engineering abstracts and is responsible for the publication of the *International Aerospace Abstracts*. As of January 1991, AIAA had published over a million technical abstracts in over one hundred languages. AIAA's Public Policy activity keeps our members aware of emerging policies and promulgates the AIAA's policy positions.

Why is the Aeronautics Industry Important to the United States?

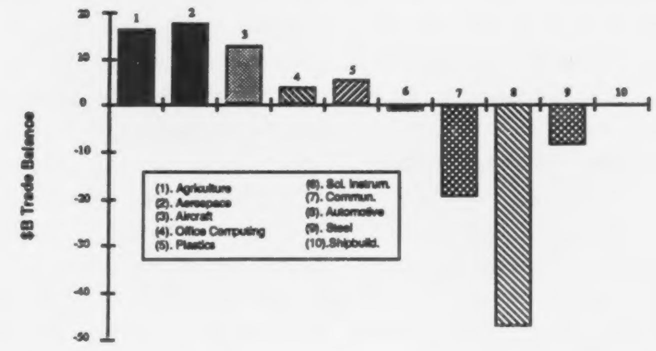
The United States emerged from the aftermath of World War II as the leader of the industrialized world. American investments in manufacturing, technology, and science dramatically increased the world's standard of living. Until recently, America was second to none in productivity, creativity, and innovation. In science, the large number of US Nobel laureates testifies to US scientific leadership after World War II. However, we are beginning to recognize that scientific proficiency alone is not a guarantee of economic success. As a nation, we are becoming increasingly concerned about transitioning our national scientific expertise and assets into products competitive in the world market.

In 1970, the United States stood at the pinnacle of technological and industrial success with a trade surplus of $800 million.[1] No single, American achievement better characterized US technological prowess than the Apollo program. For many, this achievement was the zenith of American success.

The situation has changed. Europe and Japan have rebuilt their industrial base and technology is now a commodity on the world market. In February 1990, the President's Council of Economic Advisors reported that the United States' 1989 trade deficit exceeded $129 billion dollars. In 1989, the International Trade Administration reported that each billion dollars of exports supported over 22,000 jobs[2]. By inference, the cost of the United States trade deficit has been 2.8 million jobs. These jobs represent lost revenues, lost opportunities, and other hidden costs to society that we are unable to fully quantify.

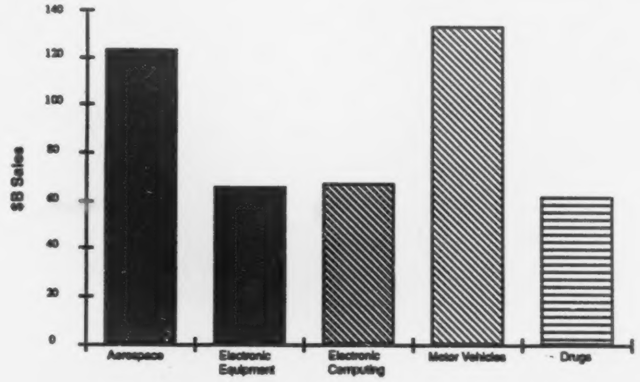
Many of the major industries that typified American economic strength, such as automotive, shipbuilding, steel, electronics, and other technology-based industries, are posting trade deficits (Figure 1). Yet, in 1990 the United States will post an estimated trade surplus of $22 billion in the aerospace sector.[3] This trade surplus, the largest in the manufacturing sector, has a large generative power. This surplus generates tax revenues that support other programs throughout the government. Today, aerospace employs over 1.3 million men and women in the United States and employs one hundred and eighty thousand scientists and engineers.[4] US aerospace sales exceeded $123 billion in 1989 (Figure 2) and were of the same order of magnitude as automotives, and electronic equipment and electronic computing combined.[5]

Aeronautics has been at the heart of US success in aerospace, representing more than



Source:*Industrial Outlook*, United States Department of Commerce, 1989

Figure 1. Aerospace Products, Incluiding Aircraft, Are Large Positive Contributors to the United States Balance of Trade



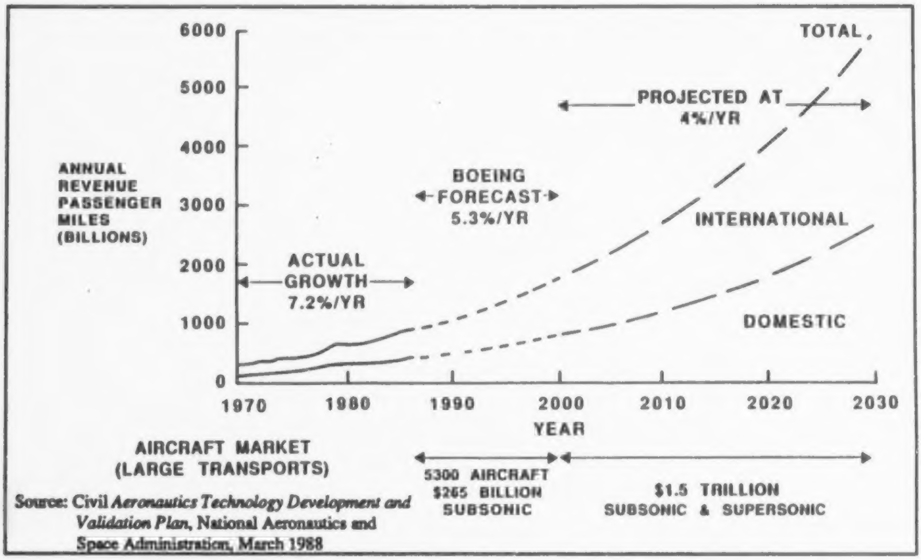
Source:*Industrial Outlook*, United States Department of Commerce, 1989

Figure 2. Aerospace is One of the Largest Sectors of United States Manufacturing

60% of aerospace sales and over 95% of exports.[6] Today the United States supplies over 70% of the Western World's civil aircraft market. The rapid growth of the transport market has been fueled by deregulation, growing international travel stimulated by emerging economies, and other economic factors. The civil jet transport market alone is expected to be worth $1.5 trillion through the year 2030 (Figure 3).[7]

This US aeronautical leadership is the result of a cooperative relationship between industry and government that began with the formation of the National Advisory Committee on Aeronautics (NACA) . NACA, the predecessor of the National Aeronautics and Space Administration, was formed in 1915 amidst concern that European aircraft manufacturers were surging ahead of US industry. NACA's pioneering research throughout all flight regimes has made important contributions to the areas of basic research and pre-competitive technology validation. Today, NASA continues to provide the R & T basis for major military and civil aeronautics advances.

Other nations have recognized aeronautics as not only a technology driver but as a strong factor in international trade and prestige. Like the United States, these nations have established policies to foster aeronautical research. As an example, agencies such as the French ONERA and the German DFVLR conduct aeronautical research and maintain and operate first–class



Source: Civil *Aeronautics Technology Development and Validation Plan*, National Aeronautics and Space Administration, March 1988

Figure 3. Civil Transport Market Projections Reflect Worldwide Growth in Passenger Traffic

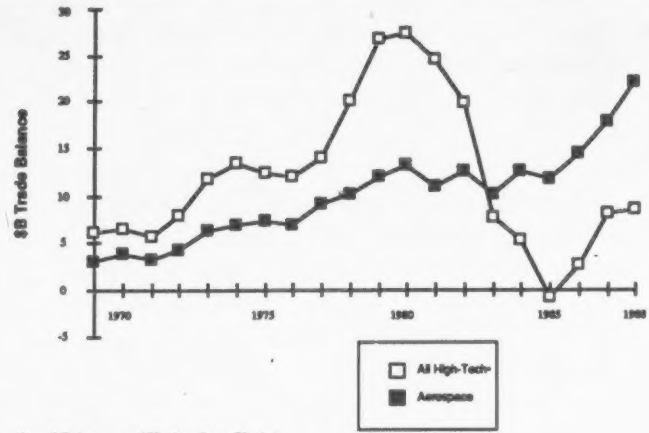
aeronautical research facilities[8]. This focus on capturing the large market in aeronautics has resulted in the development of first-class research facilities in Europe and Asia. Phil Condit, Chairman of NASA's Aeronautics Advisory Committee recently said that the United States' high speed wind tunnels are a "Close no. 2" to British and French facilities. As a result Europe now produces equipment technologically equivalent, and in some cases superior, to US products.

In addition, foreign governments, unlike the United States, act as financial risk-sharing partners in commercial product development. The success of the Airbus Industrie consortium would have been impossible without the direct participation of the four key European governments. Airbus is expected to capture 30% of the commercial jet transport market by the year 1994. The head of Deutsche Aerospace GmbH, Juergen Schrempp, doubts "...that the Airbus consortium would have survived if privately run from the start..."[9] The Federal Republic of Germany (FRG) has taken other steps to ensure the strength of the giant Deutsche Aerospace. The FRG has agreed to guarantee exchange rate losses for Deutsche Aerospace in the event of unfavorable dollar fluctuations against the West German Deutsche Mark, as part of the "sweetener" to encourage last year's merger between Dainler-Benz and MBB. As part of the same merger package, the Kreditanstatt fur Widerafbau (the West German credit bank to reconstruct the West German economy after World War II) became a 20% owner of Deutsche Airbus, the West German component of Airbus Industrie.[10] The government of the Federal Republic of Germany actively encouraged the formation of Deutsche Aerospace GmbH under Daimler-Benz, an aerospace giant with over 55,000 employees and annual revenues in excess of $7 billion.

A cooperative agreement reached between Daimler-Benz and Mitsubishi Heavy Industries of Japan is expected to bring the strong technical, management, and financial resources of the two companies to bear on the aerospace sector. With the experience that will be gained by the opening of a second Airbus A-321 assembly line in Hamburg and the vast financial resources available to Deutsche Aerospace and Mitsubishi Heavy Industries, such a partnership could become a formidable competitor in the future aeronautics market.

Since the United States does not have the competitive advantages of low capital costs and low labor costs, our trade advantages have traditionally been in the high-tech sector. But even our high–tech trade balance has declined sharply (Figure 4), except for aerospace (and especially aeronautics), which continues to show a large trade surplus. .[11]

But we are beginning to see early signs of the erosion of our technology advantage in aeronautics, too. Patents have long been considered precursors of future industrial competitiveness, and the percentage of aeronautical patents granted to US authors has declined dramatically in the last fifteen years. In 1975, the United States received 60% (428) of the aeronautical patents granted, and Japan received nine percent. In 1983, the United States received only 40% (327) of the patents granted in aeronautics,



Source: *International Science and Technology Update*,
National Science Foundation, 1988

Figure 4. Aerospace Balance of Trade Counters High-Tech Trend

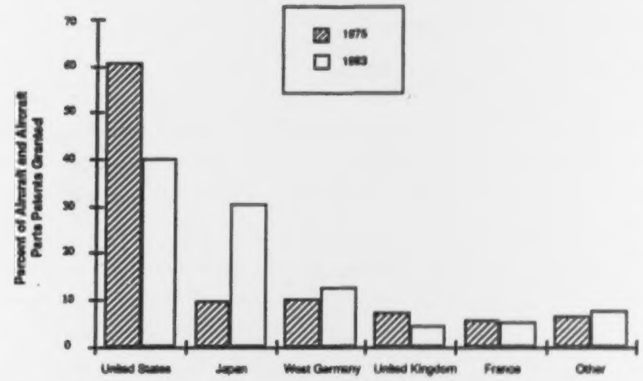
and Japan received 30% (249) (Figure 5).

The AIAA believes that aeronautics can continue to be the well-spring of US technological and industrial competitiveness well into the the 21st century. But this success can only be assured by a reinvigoration of the successful industry-government partnership that has characterized American aeronautics.

The Role of Technology Validation and Flight Research

The U.S. built a significant lead in the aeronautics field between World War II and the late 1970's. To a large extent, this lead was achieved by recognition of the need for a vigorous flight research program. Wind tunnel and computational methods have greatly improved our capability to design high-performance aircraft. Advanced, experimental methods used with ground test facilities have greatly enhanced our ability to quantify new phenomena. Sophisticated simulation techniques that include pilots as part of the system have enabled us to develop and test advanced control laws. However, these techniques must be supplemented by a vigorous flight research and technology validation program. Flight research vehicles are needed to:

- Identify new phenomena and reduce uncertainties, especially when extending the flight envelope,
- Fill the gap created by ground test facilities which do not cover the entire flight regime,



Source:*International Science and Technology Update*,
National Science Foundation, 1988

Figure 5. United States Aircraft and Parts Patents are Decreasing

- Focus and accelerate the development of advanced technologies,
- Validate the integration of one, or multiple, advanced technologies into an aircraft system, and
- Validate new design concepts.

A vigorous flight research and technology program is essential to maintaining a strong national defense. The current X-29 (Forward Swept Wing), the X-31 Enhanced Maneuverability Demonstrator, and the future X-30 National Aerospace Plane represent a significant continuation of this valuable activity. Flight research vehicles in this class have been responsible for discovering almost all known dynamic phenomena relating to aircraft stability and for demonstrating advanced control laws and systems that permit flight beyond normal, statically-stable limits. The X-29 flight program, for example, has demonstrated performance levels (associated with the integration of several advanced technologies) that were not predicted by analysis or wind tunnel tests. In some cases, these hoped-for performance gains were ridiculed before the actual flight tests.

Most important aerodynamic advances today require the integration of several discrete technologies into systems with entirely new characteristics. For instance, advanced control laws, control system components, and thrust-vectoring exhaust nozzles are combined to extend the limits of maneuverability in the High Angle-of-Attack Research Vehicle (HARV). When emerging technologies such as these are integrated into a new system, they must be validated as a system in a realistic flight environment. Modified vehicle components such as advanced wings, engines, and other subsystems applicable to advanced subsonic and supersonic aircraft can only be fully explored and validated within the constraints of a functioning, integrated system. New civil aircraft concepts that show promise for reducing airport congestion and increasing air system capacity will need to undergo rigorous concept evaluation and flight validation before the risk can be reduced to the level that will make such concepts viable options.

NASA must be able to conduct this precompetitive technology evaluation and flight validation effort in order to fully implement its aeronautics charter. There is need for an energetic pursuit of significant experimental and technology verification flight vehicles in order to provide militarily superior aircraft and economic and efficient commercial transportation, thereby retaining the pre-eminence of U.S. aeronautics technology.

Review of the FY '92 NASA Budget Request

NASA has proposed a FY92 budget of $1,029.1M for aeronautics-related efforts. This includes $591.2M for the R&D program, plus the associated $386.3M for Research and Program Management (R&PM), and $51.6M in the Construction of Facilities (CofF) accounts for facility modernization. This represents a growth of 12%, with the importance of the R&D program being recognized by a nominal 15.5% increase. In addition, there is a proposal for NASA work related to the National AeroSpace Plane (NASP) for $72M in FY92, down from $95M.

If one considers just the R&D accounts, then this FY92 total of $663.2M for the combined Aeronautics R&D plus NASP represents just 9.2% of NASA's total R&D budget proposal, down from 10.1% last year. Further, the Aeronautics R&T accounts include $15M for High Performance Computing and Communication (HPCC) that was reprogrammed in FY91 and continues in FY92, but which was taken from previously planned and authorized aeronautics efforts. Discounting the $663.2M budget for the $15M reallocation to HPCC, leaves $648.2M, or 9.0% of NASA's budget for program areas traditionally identified as "aeronautics."

Noteworthy achievements and plans for each of the program areas will follow. The proposed budget for each category is shown along with a percent increase from last year.

•THE RESEARCH AND TECHNOLOGY BASE, $375.6M (11.7%)

NASA has proposed a budget increase from $336.4M to $375.6 (11.6%) for the Research and Technology Base (R&T) related to aeronautics. The AIAA continues to support NASA in its role of providing for the advanced aeronautics technology needed to assure the technological superiority of future U.S. aeronautics aircraft and systems. This is a vital role for NASA, one which if neglected would not be adequately addressed by any other federal agency or by private enterprise. The aeronautics industry has a singularly long time scale from the identification of new technological capability to its application in civil or military aerospace products. Because of this time-frame, and the associated financial and technical risks, it is an appropriate and necessary role for our government, through NASA, to be integrally involved in conducting and sponsoring basic and applied research in the aeronautical sciences.

- AERODYNAMICS R&T, $128.3M (10.1%)

Our ability to improve aeronautical designs is increasingly dependent on our ability to accurately model the complexities of fully viscous, three-dimensional flows in several flow regimes. NASA's aerodynamics R&T places an appropriately strong focus on improving our understanding and modeling capability for such flows. It continues, where appropriate, to validate new aerodynamic concepts which can be applied to improved designs. An important example of NASA's efforts is the experimental flight evaluation of hybrid laminar flow control for reducing drag on subsonic aircraft wings. Other experimental and analytical work on the complex flowfields, noise and structural interactions of rotorcraft and STOVL[12] is also conducted under this program area.

In FY92 NASA will continue to work in these areas with special emphasis on transition phenomena in boundary layers, which can lead to improved, low-drag, laminar-flow airfoil designs. NASA will to continue work in the area of complex interactions between flowfields, the aircraft structure, and (when present) ground effects. These studies are important to increasing structural life, reducing noise and increasing aircraft performance. NASA also plans to initiate work in airframe/propulsion system integration for high speed aircraft.

The AIAA supports the basic thrust of the Aerodynamics R&T program and the specific program elements it addresses, especially the efforts aimed at subsonic and supersonic drag reduction.

- PROPULSION AND POWER R&T, $84.1M (17.3%)

Whereas the Aerodynamics R&T deals primarily with the air vehicle, the Propulsion and Power R&T program area addresses key technologies for the propulsion systems. NASA's propulsion research is focused on developing and validating advanced CFD codes applicable to the internal flow through engines and on advanced concepts for propulsion systems components.

A major continuing area of emphasis is on an analytical tool for multistage axial compressors. Achieving gains in compressor performance is one of the most challenging and expensive development tasks in any new engine program. NASA's code development could provide industry with an important new design tool. NASA also will continue efforts to develop improved, low-emission combustion systems for subsonic applications and new approaches for supersonic combustion.

AIAA believes that there are still major gains to be made in gas turbine propulsion for subsonic aircraft, and that propulsion system advances are absolutely critical to achieving our goals for supersonic and hypersonic aircraft. Accordingly we support the Department of Defense program known as IHPTET [13], of which NASA is one of the sponsors, as well as NASA's increased emphasis on Propulsion and Power.

•MATERIALS & STRUCTURE TECHNOLOGY, $42.8M (15.1%)

Materials and structures technology emphasize both the development and characterization of new materials and the necessary new design–analysis methods for utilizing those materials. NASA has had a strong program in this area for several years, and this work is increasingly important to application and development of advanced composite material systems. These composites are one of the critical, cross-cutting technologies identified on almost every critical technology roadmap as vital to achieving lighter-weight, more-durable, higher-temperature aircraft and engines. Further, composite materials will have broad application in many other industries' products.

The AIAA strongly supports continuing this work (as well as the allied Materials and Structures work under Systems Technology Programs) with the goal of enabling the broad application of composite materials to future aircraft structures and engine components.

•CONTROLS, GUIDANCE, AND HUMAN FACTORS, $67.6M (12.1%)

NASA's work on controls, guidance, and human factors concentrates on technology issues which can have major payoffs in improved safety and operational effectiveness of air traffic management. The 1988 report of the OSTP APRC [14] stated that the most pressing issue facing the aeronautics community was global air traffic control. This concern was the result of the rapid increase in global air travel and the strains this is placing on worldwide system capacity. This is a responsibility shared by NASA and the FAA, which are cooperating in this research area. Technology exists which, if validated, can have major impacts on improving the safety and capacity of our national and international air transportation system. Recent successful demonstrations by NASA such as instrumentation to detect atmospheric microbursts, and use of aircraft GPS [15] data to control landing separations, are excellent examples of what can be achieved.

AIAA supports NASA's continuing efforts on advanced controls, sensors, flight management technology, and cockpit automation. Systems and strategies to detect and survive hazardous flight conditions should receive priority attention. Optimal controls and advanced cockpit technology integrated with air-traffic controls should be pushed on a rapid timetable to mature and implement this technology.

• FLIGHT SYSTEMS R&T, $42.1M (4.2%)

Flight systems research addresses important realities of the flight environment (such as icing), complex flowfields (like high-angle of attack flight), and system integration effects (such as transition between modes for STOVL aircraft). The work is a challenging combination of analytical modeling, innovative configurations and difficult ground and flight experiments.

FY92 programs will focus on these same three subjects: icing phenomena, high angle-of-attack flight, and STOVL. AIAA recognizes that NASA has a long tradition and unique capability in this area which must continue to be exploited for the benefit of our national aeronautics program. At the same time, we wish to enter the observation that much of this program is relevant primarily to military aircraft.

• SYSTEMS ANALYSIS, $10.7M, (3.9%)

The systems analysis program element, though small, is important because it provides much–needed quantitative evaluations of potential areas of research. The program provides guidance concerning which concepts and technologies have the highest potential payoffs. AIAA concurs with NASA's plans to continue this effort at the proposed level of effort.

• SYSTEMS TECHNOLOGY PROGRAMS, $215.0M (22.8%)

Every report of the OSTP Aeronautical Policy Review Committee stressed the importance of technology validation and called for increased effort in this area of R&D. In 1985 they said,

> *"The most critical area is technology validation, ... National policies and implementing procedures ... have driven unintended barriers into this critical mid-phase of R&T, causing this vital link in the innovation chain for aeronautics to be short-circuited."*

In 1987, the APRC said,

> *"Technology validation is currently the weak link in the R&D chain. Validation enables designers to incorporate new advances into a product with confidence in its performance, integrity and certificability. It is the longest and most expensive stage in advancing new technology. It is also the point where U.S. R&D momentum has become most vulnerable."*

In 1988, the report read,

> *"As a result, several important subsonic technologies have not been sufficiently validated for incorporation into commercial aircraft development programs at acceptable levels of risk."*

As one of the responses to these messages, in 1987 Congress directed NASA "to prepare a multi-year technology development and validation plan that will help the United States retain its leadership in aeronautics research and technology and compete in the international marketplace for future civil aircraft." [16] Much of the NASA Systems Technology Program that we are reviewing comes from that planning effort. The AIAA concurs strongly with the conclusions of the APRC and with the direction of Congress in this matter. We have reviewed the 1988 Civil Aeronautics Technology Development and Validation Plan prepared by NASA and fully support its major thrusts.

We are pleased to see the growth in the Systems Technology budget area over the last few years, and we would like to encourage both the Administration and Congress to continue building up this area so that we can more effectively transition the investment in basic R&D to a state of development within reach of industry.

Comments on the specific Systems Technology Programs follow:

- HIGH-PERFORMANCE COMPUTING, $17M, (unchanged)

The AIAA commends the Administration and Congress for their roles in encouraging and supporting the High Performance Computing and Communication program, and for NASA's key leadership role in advanced software. These efforts are important to the nation and will have broad payoffs to the nation's technological competitiveness, including aeronautics. It is also important to recognize that while NASA's efforts on this program are recorded under Aeronautics Research and Technology, the planned HPCC effort represents a dilution or deletion of aeronautics effort. Although some advanced CFD algorithm development is planned under this program, the emphasis is on systems software for massively parallel computers.

- MATERIALS & STRUCTURES SYSTEMS TECHNOLOGY, $40.1M, (0.5%)

This area of work will focus on the design and fabrication technology required to apply advanced composites to major aircraft parts and engine components. Rather than work at the coupon level, as is done in the technology base area, this effort will design and fabricate large-scale structures. Included in the plans are basic aircraft structural elements such as wing boxes and fuselage panels.

Advanced composites are an area receiving world-wide attention. Japan and France have massive programs and significant capability in composite materials. These "designer materials" will require a totally new, integrated approach to design and fabrication. They offer the potential for massive weight savings if efficient fabrication techniques can be developed and if it can be demonstrated that composite materials will hold up under actual service conditions.

NASA's augmentation in this area, supplementing and extending the materials and structures technology base, is strongly supported by the AIAA. NASA's program in this area appears exceptionally well-planned and comprehensive, except that there is no mention of improving Non-Destructive Examination (NDE) methods for composites.

- ROTORCRAFT SYSTEMS TECHNOLOGY, $5.2M (2.0%)

Most of NASA's effort on rotorcraft is funded in the Technology Base area, rather than in this program element; although the total is only $25.3M. The United States' helicopter industry has steadily lost ground to foreign competition and now has a minority share of the world market. AIAA sees significant market opportunities for technically-superior rotorcraft and would like to see this category increased.

The work that is proposed under this program element is aimed at addressing noise reduction efforts and other certification issues for tilt-rotor aircraft. Considering the important domestic and international market that has been forecasted for a successful civilian variant of the V-22, and the relief such a system could give to some of our airport congestion problems, we would recommend this as a program which should be accelerated.

- HIGH PERFORMANCE AIRCRAFT SYSTEMS TECHNOLOGY, $11.1M (5.7%)

This program area appears to be primarily an augmentation of the Flight Systems base R&T program, allowing increased effort on technologies applicable to advanced military aircraft, and it has been responsible for evaluating the feasibility and merit of thrust-vectoring concepts for highly maneuverable aircraft and several advanced flight controls. Along a different avenue, one of the efforts planned for FY92 is the evaluation of supersonic laminar flow possibilities that would have applicability to both military supercruise aircraft and a new civilian high-speed transport. The AIAA endorses these efforts at the planned level of effort.

- ADVANCED PROPULSION SYSTEMS TECHNOLOGY, $15.4M (2.7%)

The Advanced Turboprop Systems element concentrates on the ultra-high bypass engine. The technical work seeks to develop an integrated design and analysis capability for the aerodynamic, structural and acoustic performance of ducted propellers. Experimental work will be used to verify noise levels and investigate noise reduction and cancellation approaches.

The General Aviation/Commuter Engine Technology program aims at improving smaller-sized engine components appropriate to applications in this market. Specific programs address advanced combustion technology and radial-flow turbomachinery.

Both of these program elements can lead to incremental improvements in propulsion systems, but the level of effort is insufficient to produce major advances.

- NUMERICAL AERODYNAMIC SIMULATION (NAS), $45.4M (2.9%)

The NAS, and the research environment which surrounds it, is conducive to exploring innovative approaches to major problems in computational fluid dynamics. The work done is often first-of-its-kind demonstrations that could not be conceived or executed on machines with less computing power. AIAA applauds and supports the continuing contributions of NASA's Numerical Aerodynamic Simulation program.

- HIGH-SPEED RESEARCH, $76.4M, (73.6%)

The High-Speed Research program is clearly, and appropriately, the showpiece of NASA's Systems Technology Programs. This technology could set the stage for a next-generation High-Speed Civil Transport (HSCT) with major international market opportunities. Over the next four decades, the most rapid growth in passenger traffic will be for inter-continental, over–water routes. Market studies show that an environmentally-sound and economically-competitive HSCT could capture a significant fraction of the commercial transport market estimated to be worth $20-50 billion per year. The potential of this market is not lost on our international competitors. Europe and Japan have initiated well-funded programs aimed at this opportunity.

For these reasons, the OSTP Aeronautical Policy Review Committee recommended accelerated pursuit of the enabling technologies: supersonic laminar flow, thermoplastic and metal–matrix composites, and supersonic through-flow and variable-cycle engines. They also recognized that environmental feasibility must be established. Further, they recognized that the scope and importance of this effort probably requires and justifies a consortium of U.S. manufacturers to design and produce this system.

AIAA concurs with the importance of this opportunity and the need to accelerate our technology efforts in that direction. For that reason, we strongly endorse NASA's emphasis on High-Speed Research. The first phase of the HSR program addresses the significant environmental issues: emissions, noise (airport), and sonic boom. The program has produced encouraging preliminary results that indicate that the emissions and community noise problems can be successfully resolved, although much more work is clearly needed.

During FY92, effort would be initiated also on advanced materials needed for the high-temperature combustion and exhaust systems needed to achieve low NOx emissions and low noise. In the near future, these component concepts will need experimental verification.

• ADVANCED SUBSONIC TECHNOLOGY, $5.0M, (new)

This effort was planned as a program augmentation to speed up efforts aimed at increasing the safety of existing aircraft, to demonstrate technologies that would allow increasing airport capacity and to provide advanced wing design and control system technologies needed for international competitiveness. This program was a primary goal of the Aeronautical Policy Review Committee Reports.

Because of budget constraints, the Administration has only submitted the fleet safety and advanced fly-by-light/power-by-wire (FBL/PBW) controls for FY92 and has elected to defer airport capacity enhancement technologies and integrated wing designs at this time. Although AIAA recognizes the reality and desirability of constraints on the federal budget, we regret the deletion of these program elements. Given the already evident airport congestion, forecasts for growth in traffic, and the time delay before any proven technology can be implemented on a national scale, we should not delay any work on promising technologies that could help alleviate these problems. Similarly, given the immense size and economic importance of the subsonic commercial transport market and the technical challenges and market goals of our European competitors, we should proceed aggressively with any technology applicable to this class of aircraft.

How Can NASA Contribute to the Health of the Industry?

Since 1915, the United States' national policy has called for leadership in aeronautics. The role of ensuring this lead was first assigned to NACA and then to its successor, NASA. Other governmental agencies make contributions, but their roles are minor by comparison. An integral part of this national policy is the pursuit of technology and its application. NACA's independent approach to fundamental research created the synergism that sparked U.S. aeronautical supremacy in wartime and preeminence in peace.

During the 1950's, NACA and DoD developed the axial flow jet engine and the swept wing. These technologies were the foundation of a new generation of aircraft that revolutionized public transportation and ensured three decades of U.S. dominance in commercial aviation. A significant development in the 1960's was the high-bypass-ratio turbofan engine. This concept more than doubled takeoff thrust, improved fuel consumption, and reduced engine noise appreciably. Similar opportunities for advances still exist.

In 1958, when NACA was absorbed into NASA, the character and substance of U.S. aeronautical research was affected. Emphasis was placed on space priorities while funding and manpower for aeronautics declined. Though U.S. aircraft still maintain a broad technological advantage, the margin of that advantage has narrowed dramatically.

Foreign governments have implemented policies to capture a greater share of the aeronautical market. Their technologies are now comparable, if not superior, to those of the US in some areas. The direct support foreign governments give to their industries goes beyond fundamental research and technology validation and involves financial underwriting of product programs.

Competitiveness in the international market is the result of many factors. These factors include design concepts that meet airline requirements, superior manufacturing capability and capacity, cost-effective processes, access to capital, fair competition, and technology readiness for safety and economic utility.

The full R&D cycle can be viewed as a chain of events leading to production: basic and applied research, technology validation, and product definition and development. NASA's historical role is research and technology validation. It is industry's role to define market needs, to conceive products, and to develop and incorporate technology into products.

Technology validation is the critical link between NASA and industry efforts. Recent budgetary constraints have severely curtailed NASA's efforts in technology validation. Future advances in aeronautics require a more aggressive NASA effort in technology validation as well as research.

NASA's budget should reflect the contribution that commercial aeronautics makes to the U.S. economy and balance of trade. The US aerospace industry depends on the continued use of advanced technology, and this technology has its roots in the research performed by NASA. Technical superiority will be difficult to achieve by either the U.S. or our competitors. Technical inferiority, on the other hand, is as simple as believing there is no threat and investing accordingly.

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[1] *Economic Report of the President*, Council of Economic Advisors1990, pg. 406
[2] *Ibid*
[3] *United States Trade Performance*, Department of Commerce, 1988
[4] *Aerospace Facts and Figures*
[5] *Ibid*
[6] *Industry Outlook*, Department of Commerce 1989
[7] *Aerospace Facts and Figures*, AIA
[8] *Civil Aeronautics Technology Development and Validation Plan*, NASA, 1988
[9] *Office National d'Etudes et de Recherces Aerospatiales* (ONERA) and *Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raufahrt* (DFVLR)
[10] *Aerospace Daily*, May 21, 1990, pg. 298
[11] *Aviation Week and Space Technology*, Jan. 29, 1990, pg. 77
[12] *Ibid*
[13] *International Science and Technology Data Update*, National Science Foundation, 1988
[14] Short Take-off Or Vertical Landing
[15] Integrated High Performance Turbine Engine Technology
[16] Report of the Aeronautical Policy Review Committee, J.E. Steiner, Chairman, to the Office of Science and Technology Policy, August 1988.
[17] Global Positioning System
[18] Report of the Senate Committee on Commerce, Science and Transportation, NASA Authorization Act for 1988, June 24, 1987.

APPENDIX A

Ronald E. York, Ph.D.

Allison Gas Turbine Division
General Motors

Education: B.E.E., General Motors Institute, 1966
M.S.E., Purdue University, 1969
Ph.D., Purdue University, 1973

Honors: GMI: Robot Society, Tau Beta Pi and Albert Sobey Memorial Award
General Motors Fellow, 1969 - 1970
Society of Sigma Xi
SAE White House Fellow in the Office of Science & Technology Policy, 1989 - 1990

Professional Affiliations:
Member: ASME, AIAA, SAE
Registered Professional Engineer: Indiana

Summary of Experience:

Dr. York returned to Allison as Director of Advanced Engine Projects in September 1990. In this position, he is responsible for integrating Allison's advanced component, materials, and structural technology into advanced demonstrator engines. The purpose of these engine demonstrators is to evaluate the feasibility and benefits of incorporating these advanced technologies at the system level. Dr. York's staff is currently working on five engines, covering both subsonic and supersonic, manned and unmanned applications.

From August of 1989 through August of 1990 Dr. York was an SAE White House Fellow in the Office of Science and Technology Policy. Dr. York served as a Sr. Policy Analyst at OSTP working on issues associated with the competitiveness of U.S. industry. Areas of responsibilities included the first National Critical Technologies Report, aeronautics policy, science and technology information policy and technology transfer from the federal laboratories to the private sector.

Dr. York has been an employee of Allison Gas Turbine Division of General Motors since 1961. His career has focused on the development and application of the advanced technologies needed for high performance turbine engines. He has functioned both as an individual researcher and as an engineering manager in several areas, including: advanced experimental and computational fluid mechanics, high temperature heat transfer, combustion systems and advanced electronic controls.

APPENDIX B
Aeronautical Policy Subcommittee
American Instute of Aeronautics and Astronautics

Dr. Ronald York, *Chairman*
Director
Advanced Engine Projects
Allison Gas Turbine Division
General Motors Corporation

Mr. John Buckner
Vice-President
Special Programs
General Dynamics

Dr. Norris Krone
Executive Director
University Research Foundation

Mr. Robert Lynn
Senior Vice-President
Research and Engineering
Bell Helicopter Textron

Dr. Stanley Rosen
Vice-President
Public Policy
American Institute of Aeronautics and Astronautics

Mr. Cal Watson
Manager
Boeing Commercial Airplane Company

Mr. H. Robert Welge
Manager
Advanced Projects
Douglas Aircraft Company
McDonnell Douglas Corporation

Mr. Bradford Biegon
Deputy Director
Science & Technology Policy
American Institute of Aeronautics and Astronautics

Mr. **Valentine**. Thank you, Dr. York. In your opinion, is a high-speed civil transport which can fly supersonic within 200 miles of land—is that an economically attractive prospect? They are laughing at me because they think the bell has rung on me before I even got started good, but that was a malfunction of the machinery.

Dr. **York**. You are blaming it on technology, sir?

[Laughter.]

Mr. **Valentine**. No, I am blaming it on the technology operator.

Dr. **York**. I like that answer.

The issue you raise is, of course, exceedingly relevant to the economic viability of the high speed transports. Even with some restrictions, it seems to be clear even at this early date that certain specific routes, particularly transoceanic Pacific routes, could still be very viable. The Pacific routes are the fastest-growing segment. There are several evaluations going on of technical and economic considerations as to how that restriction might be moderated or dealt with. It is not conclusive at this point in time that a 200-mile supersonic limit would necessarily be required.

Mr. **Valentine**. How much more noise can we squeeze out of these airplanes and have an effective or sensible operation? Where do we get to a place where the cost of attempting to do this is astronomical?

Dr. **York**. That is also relevant, especially for any of us that have to deal with airports with nighttime curfews, or live near an airport, we know problems like that occur. Of course, both issues you raised, the first one which was the overflight problem, and now you are addressing the community noise for airports—I don't think at this point in time we know what is acceptable, other than the current limits. The question really is, what can we do about it.

There are approaches that appear to be feasible, that could meet current limits. We need to control engine noise, particularly exhaust systems, and NASA is working in that area, and I think basically in the right area. They have some preliminary demonstrations which are encouraging. We need high-lift devices so we can get the airplane off the ground and out of the area quickly and moderate the problems also.

It is a concern not only in the United States, but probably equally or even more of an urgent concern to some of the Europeans. Of course, we would ultimately want access to that market also.

Today, we have aerodynamic prediction codes and noise prediction methodologies that are a pretty well-integrated design system, and are much superior to anything that existed even five years ago. We are able to consider optimizing configurations and doing tradeoff studies to address these problems. I am not an expert in noise, but the engineer in me tends to think these are tractable problems, that we can find an acceptable solution.

Mr. **Valentine**. This is neither the time nor the place to get into this sort of thing, but I think it would be very interesting to have detailed information region by region in this country as to those people who are involved in initiatives having to do with the noise around airports, when some of them moved into the areas, when the airport was there, when the housing that they purchased was put up next to the runway.

Some very knowledgeable person said to me recently "You know, the noise from these airplanes has a sound of money, has a sound of economic development and prosperity. Maybe we should be able to tolerate more of it." Except, of course, where my own constituents are.

[Laughter.]

Mr. **Valentine**. Has the AIAA addressed the dilemma confronting the owners of the reciprocating engine fleet arising from the banning of new engines that use leaded gas?

Dr. **York**. I am only barely aware of that issue. We did conduct a study last year in the AIAA about general aviation concerns. That particular issue did not come up in the agenda. We need to go back and query the headquarters staff and our technical committees and see if there has been any work on record. We will be glad to provide that to the committee.

Mr. **Valentine**. Thank you, Dr. York. Mr. Lewis?

Mr. **Lewis**. Thank you, Mr. Chairman. Mr. Chairman, some of the members who cannot stay for the entire hearing may have additional questions for the record. I would ask unanimous consent that members have permission to submit their questions in writing.

Mr. **Valentine**. Without objection.

Mr. **Lewis**. Thank you, Mr. Chairman.

Dr. York, do you feel that the funding level proposed for the fiscal year 1992 NASA budget is adequate?

Dr. **York**. I understand we are working with constrained budgets. Adequacy probably depends, in my sense of definition, on whether we properly exploit the opportunities before us. I am very pragmatic in that regard. I think that considering the stakes that are present and the technical opportunities, that we are, in fact, constrained by budget and not by technical capability. I would encourage the committee to give every possible consideration to increases in the budget.

Mr. **Lewis**. Have you listed anywhere what you feel your organization's priorities may be?

Dr. **York**. Our priorities in the past, and we have given some emphasis to that in previous testimony, and indirect conversations with NASA, are to increase technology validation in all its phases, both ground phases and flight testing. We are certainly pleased to see that this is the largest area of increase this particular year.

However, the increases are primarily in systems that will not enter in service until 2005 or 2010 or thereabouts. The areas of advanced subsonic technology, rotorcraft systems and the propulsion systems were in fact quite low and did not, in some cases, even keep pace with economics. If we were to put a prioritization on it, it would be that we accelerate the new initiative on advanced subsonic technology, perhaps adding another $5 million to that, and try to keep the rotorcraft and propulsion systems at least funded at the current level of effort.

Mr. **Lewis**. How is your assessment of how the NASA wind tunnel revitalization program is going? In addition to that, how do you feel our wind tunnel facilities compare to foreign facilities?

Dr. **York**. I am not as personally familiar with that as I would like to have been by now. That is an area of homework I still have to do.

I think it is very important to us. Those facilities are national facilities and are used extensively. Foreign countries have excellent facilities, both in the classic things such as wind tunnels and in some cases some rather unique facilities. An example I am aware of is a cold neutron facility in Great Britain, I think at Pyestock. They are basically able to put an entire running gas turbine engine up in front of it, watch the oil flows and running clearances of that engine. That is something I would dearly love to be able to do with some of my engines, but I can't afford a nuclear reactor to do it.

We are facing a very well-equipped competitor in the world environment. It is important that we keep our facilities and our instrumentation technology very modern.

Mr. LEWIS. What is the program that you have at AIAA in respect to education for the acceleration of studies for scientists and engineers, mathematicians and computer technologists? Do you have any program or priorities established in those areas?

Dr. YORK. I would like to introduce Brad Biegon, who is the Deputy Director for Public Policy at AIAA. He is more aware of activities in that area, if he could answer your question.

Mr. BIEGON. Mr. Valentine, Mr. Lewis, thank you. For the record, my name is Bradford Biegon. I am Deputy Director of Science and Technology Policy at AIAA.

The Institute, like most organizations and certainly the Government, has recognized engineering education as a critical element in the survival and success of our country economically in the future. Our Institute Development Committee, which selects programs for the Institute to pursue in the future, a future major thrust of the Institute has selected education as one of its key priorities, we have produced a videotape we are making available now for elementary and high school students on aerospace careers.

We also have very active programs at the local levels to put our engineers directly in contact with high school students. This is done both through AIAA, its local sections, as well as the actual members working through their employers in corporate-sponsored programs.

As an example, AIAA in an outreach kind of program in Los Angeles over the last five years has invited high school students from the poorer areas of Los Angeles' unified school district to attend one of our major conferences and engineering displays. We invite the students to tour the exhibits, meet with people from the industry, and we also have panel discussions and slide shows with the students afterwards. We have put a variety of people in front of these students, ranging from engineers, business professionals, and military people to talk to them about career options.

I think those types of initiatives are critical. Much of this work needs to be done at the community level, frankly. It's the only way you are going to reach young people like this. But if I may, on a personal note, the only way to really guarantee people will enter colleges and universities is to have a secure industry. Our industry is known for being cyclical. That is certainly going to discourage bright young men and women from entering the profession if every seven years they run the risk of losing their jobs.

We need to raise engineering to the status of the profession that it is in this country. In many senses, we need to make it more attractive than some of the business professions. We lose people out of engineering shops every day to MBA programs, law programs and other valuable professional programs. But we lose the engineers. If the United States is going to continue to lead in this market, we need to retain those people in the profession for what they know and for the contributions they can continue to make.

But we can't have the kinds of funding cycles we see where someone invests anywhere between four and seven years in his education and then runs the risk of losing his job about as often.

We have to address that at a governmental level, as well as a community level, and we welcome stabilized funding for programs. As a profession, we hope we can play with that as well, and support it.

Thank you.

Mr. LEWIS. What is the heart of your program, the three-year association to your industrial members, in respect to working at the community level? Are you encouraging them to work at the community level, for example, having engineers volunteer as tutors for high school students, such things as that, in order to get through their math programs?

Mr. BIEGON. In fact we do that. To be honest, we would like to do more. We have initiatives in this area to build that up.

In my other incarnation, before joining AIAA staff, I was with our Young Members committee, which was basically a committee to foster the development of young professionals in the Institute. I am very proud to say we took a leadership role in doing that. We did put our engineers, our members, into classrooms with students, with individual students, with groups of students, to help with their math, but also to provide sort of a mentoring.

One program we had on the table that I hope we can eventually pursue is to take students on everything from tours of aerospace facilities to colleges as a follow-on to this type of thing. It is not just enough to go in once a week and talk to these kids, particularly in some parts of the community where professional options are not traditional, if you will, to show them that these are the kinds of careers they can pursue, and here are the steps that need to be taken in order to do that.

We need to show them that this is what the university community is like, this is what the industry is like. Those are some of the things that happen. Again, members are participating actively in helping people with tutoring and things like, again through some local programs as well as through corporate programs.

Mr. LEWIS. Thank you. Thank you, Mr. York.

Mr. VALENTINE. Mr. Bacchus?

Mr. BACCHUS. Thank you, Mr. Chairman.

Dr. York, I want to congratulate you on your testimony, especially on the historical perspective that it provides. I believe it should be recommended reading for anyone who is of the notion that the triumph of American aerospace has been solely a product of the virtues of laissez faire capitalism in which government plays no role and lets the magic of the marketplace work its will.

I have a few questions in that context. First of all, in your full testimony, you offer some frightening figures about the patents for aeronautics. I will read excerpts, since you did not have the opportunity to read it all: "Patents have long been considered precursors of future industrial competitiveness and the percentage of aeronautical patents granted to U.S. authors has declined dramatically in the lats 15 years." You then go on to point out the differences between the U.S. receiving 60 percent of the patents in 1975, and only 40 percent in 1983, while the Japanese percentages rose dramatically.

First of all, are there any more recent figures than 1983?

Dr. YORK. Thank you, Mr. Bacchus, for the compliment. I sincerely appreciate that.

This patent story is not unique to our industry, of course. It is data that Mr. Biegon brought to our attention, and we thought it was significant enough to include for the benefit of the record and the committee. I am not aware of more recent information that are available to us right now.

Mr. BACCHUS. To what would you attribute this dramatic change?

Dr. YORK. Certainly to take nothing away from our competitors, they are improving. Their capability to be innovative has been perhaps underrated in the past. Their technology is improving and they are extremely aggressive at finding a way to incorporate that technology into products.

Mr. BACCHUS. I would not be so much concerned about the changing percentages if we had shown an overall real increase in the total numbers of patents in the United States. Instead, these numbers show a decline.

Mr. BIEGON. Again, Mr. Chairman and Mr. Bacchus, excuse me, but maybe I can answer this.

That's right, patents have in fact remained roughly flat during the time that was studied. So the penetration of the Japanese and some of our other competitors is real. One of the difficulties is that the document that was obtained from the National Science Foundation's International Scientific and Technical Trade document, the most recent copy covers the years up until 1988.

One of the difficulties that struck me in supporting Dr. York's preparation is we don't have enough collected data readily available to perform these kinds of analyses. This is strictly and purely a personal opinion. I would very much welcome some kind of unified place to go and get those kinds of things. I believe this is something other governments do to support their professions and industries. If there is a way we would do that now, I think that would help our industry and profession as well.

Mr. BACCHUS. I have a related question. You make mention, as well you should, of the direct government support that our competitors are receiving—Airbus, the various co- ventures involving Japan and the Germans. How do we compete with that, short of having the United States Government participate as an equity partner in the aerospace industry?

Dr. YORK. That's a real tough question for an engineer. I am not proposing that we do similar things in terms of equity participation. I would encourage that we work very hard to make sure we have the technology base, that we are providing the right technologies, and that we increase our efforts in areas that can help transition the technologies. That's probably where the principal weakness has been.

Mr. BACCHUS. You have emphasized that, and I think rightly so, in your testimony in terms of technology validation and a systems technology program where we show a dramatic increase. You also applaud the increase in research and development on high speed air transport, again mentioning the foreign competition we have.

You make mention in passing of the recommendation by one of these academic groups that is involved of a consortium of U.S. manufacturers as the way to proceed beyond just a Government R&T itself. Is that something you feel will be necessary in order to compete with the efforts of the Japanese, the Germans, the British and others to get this next generation of high-speed aircraft?

Dr. YORK. That's a very perceptive insight. This industry is relatively unique, in that it will support, in any given market segment, only a limited number of producers. It is expected that for the next generation of supersonic aircraft that there ultimately be a single producer, a single system operational. The question is, who will build that? Will it be an international consortium or a domestic consortium in the United States?

But it is unlikely that a single corporate entity will have anywhere near the resources needed to carry that off.

Mr. BACCHUS. You would think a consortium is necessary, of some sort?

Dr. YORK. That is the prevailing opinion.

Mr. BACCHUS. Thank you, Dr. York, thank you, Mr. Chairman.

Mr. VALENTINE. Mr. Rohrabacher?

Mr. ROHRABACHER. Dr. York, I am sorry I missed your testimony and I will be reading it. When you are a Congressman sometimes you have to talk to your constituents. I was called back to the back of the room to talk to some constituents that are in town.

I would like to ask you some questions to follow up on what I was asking the previous person there, Dr. Aldrich. How would you analyze the effect of things like the FSX fighter deal, and co-venture deals we have made with the Japanese on things like the Patriot missile, and the list goes on, the Aegis cruiser, the FSX fighter, where the Japanese have not been willing to purchase the final product, the weapons systems, but instead have insisted on joint ventures and then buying the technology, which enables them to build their industrial base in the aerospace industry?

Dr. YORK. Thank you for the question, Mr. Rohrabacher. I have no particular personal insight into the FSX. Watching it with great interest, as most people in or related to the industry do, I am aware that there is an argument to be made on both sides; that the FSX deal would in fact help Japan create their own industry, and people that are equally convinced that it precluded them from starting their own indigenous aircraft industry.

I think it is too early to tell which result will really come from that.

Mr. ROHRABACHER. Do you think that prohibiting aerospace firms from selling technology rather than selling products would damage the industry significantly? Obviously there are short-term profits made by companies that are willing to sell the technology that has been developed by Department of Defense contracts. But in the long-term those may be detrimental. Would there be a real short-term detriment to companies if we prohibited that?

Dr. **York**. That's an equally valid concern. International agreements, joint production ventures, are often made with several reasons, even domestic ones when they occur. Many years ago, the predominant reason was probably the access to technology. Today, the reasons, the priorities are usually more for economic risk sharing and for access to markets. Technology is a secondary concern. Most companies try very hard to give up as little technology as they can. They are going to be reasonably protective of their own interests.

But I understand your concern, and certainly share it, and realize that it is something that requires continued scrutiny.

Mr. **Rohrabacher**. Thank you very much. Mr. Chairman, thank you.

Mr. **Valentine**. Thank you.

Thank you, Dr. York, and Mr. Biegon. We appreciate very much this presentation.

We will proceed now to the final witness for today's hearing, Mr. Samuel Keller, Deputy Associate Administrator, Office of the Administrator, National Aeronautics and Space Administration.

Welcome, Mr. Keller. Your prepared statement will appear in the record as presented to us, and we would appreciate it if you would summarize your statement to condense it to about five minutes.

Thank you, sir, welcome, and your associates, Mr. McGarvey, and Mr. Anderson. Welcome to all of you.

STATEMENT OF SAMUEL W. KELLER, ASSOCIATE DEPUTY ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION; ACCOMPANIED BY: GENERAL BILLIE MCGARVEY, ASSISTANT ASSOCIATE ADMINISTRATOR, FACILITIES ENGINEERING, NASA, AND PAUL ANDERSON, DIRECTOR, INSTITUTIONAL RESOURCES AND ANALYSES

Mr. **Keller**. Thank you, Mr. Chairman. It is indeed a pleasure to be here, and I will be more than pleased to submit my statement for the record and give you a brief summary.

Before I begin that, on my right is General Billie McGarvey, who is the Assistant Associate Administrator for Facilities Engineering at NASA, and on my left, Paul Anderson, who is the Director of Institutional Resources and Analyses.

Today we very much appreciate the opportunity to appear before this committee to discuss the facilities maintenance activities within NASA. We acknowledge that there have been serious problems over the last few years, that the funding has been much less than we would desire.

However, in the last few years, we have conducted a number of studies and efforts to emphasize facilities maintenance. We believe that we are beginning to have a better understanding of how to effectively accomplish the programs and operations in the context of that program.

Culminating in September of 1989, a series of agency reviews established a concern for adequate funding of this very important function. In the preparation of the fiscal year 1990 budget request which came to Congress, we provided for increased support. Unfortunately, the appropriations we received were somewhat less, however, the growth that has taken place has resulted in an increase from 1989 funding of $162 million to a request of $229 million in 1992. This is a direct result of these efforts on the part of the Agency's management.

Following those initial surveys, during the 1989-1990 period, we conducted a more formal survey within the agency of our maintenance problems. General McGarvey's organization developed a greater in-house expertise, and we brought on board a specialized support contractor to help us conduct the study. As a result of that study, we further defined the problems. We recognized the National Research Council Building Research Board criteria, which recommends that maintenance funding be in the range of two percent to four percent of the replacement cost of a facility.

The NASA budget for facilities maintenance and minor repair projects in fiscal years 1991 and 1992 is currently within the lower edge of that two percent to four percent range. Our objective is to get it to the three or three and a half percent range within the next few years.

There was, as I am sure the Committee is aware, a recent survey by the General Accounting Office of our maintenance problems. They basically agreed with the conclusions that we have arrived at. In the interests of precluding any possible misunderstanding regarding these activities, it might be helpful for me to briefly outline the funding techniques we use in the maintenance area.

First of all, we fund maintenance from all three of the major NASA operating appropriations. There is the research and program management account, the research and development account, and the space flight control and data communications account. These all go to maintenance. We have a fourth account, construction of facilities, which principally funds new construction as opposed to maintenance. Although, on occasion there have been some overlaps.

To conform with Congressional concerns and guidance regarding appropriations integrity, the R&PM maintenance funds are used primarily for institutional-type facilities. The R&D and SFC&DC funds are used mainly for technical and program support facilities. The facilities maintenance funds are budgeted and allocated to the field centers by our respective NASA Headquarters, Institutional and Program Offices.

In turn, we have delegated to the Center directors the responsibility and authority for carrying out necessary maintenance in their field centers. We do this to provide them the necessary flexibility and latitude that are necessary to enable them to respond to problems as they arise.

Mr. Chairman, I want to reassure you that we recognize that our unique NASA facilities are national resources, that we have embarked on a new, long-term initiative to improve and increase the maintenance of these valuable assets. The increased funding allocated for this purpose in fiscal years 1991 and 1992 I believe is indicative of our focused efforts to do this.

This concludes my summary. I would be more than pleased to respond to such questions as you might have.

[The prepared statement of Mr. Keller follows:]

STATEMENT

of

Mr. Samuel W. Keller
Associate Deputy Administrator

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

before the

Subcommittee on Technology and Competitiveness
Committee on Science, Space and Technology
United States House of Representatives

Mr. Chairman and Members of the Subcommittee:

I appreciate this opportunity to address our Facilities Maintenance activities within NASA, and I want to emphasize that we clearly recognize the critical need to properly maintain the NASA physical plant which enables us to successfully carry out our assigned missions.

We readily acknowledge that fiscal constraints have at times forced us to allocate less funding than we would desire to maintenance requirements. It is also true that in almost any organization or community, maintenance needs must be weighed along with other important priorities and sometimes suffer from the fact that they can be delayed without an immediate impact from the deferral being felt. We have often seen this problem in state and local Government.

However, in the past couple of years, NASA has undertaken concerted efforts to improve and increase our facilities maintenance capabilities. A basic objective of these efforts is to maintain our facilities in a condition which permits the Agency to effectively accomplish all of its programs and operations. In this regard, we are striving to treat facilities maintenance as a cost of doing business which cannot be deferred, similar to paying salaries for personnel and costs for utilities.

Internal reviews at NASA culminating in September 1989 clearly established both our concern for maintenance and our near-term funding needs. This resulted in an increase for this purpose in our FY 1991 budget request to Congress. Unfortunately, reductions and constraints in the total NASA budget resulting from final appropriation actions did not allow us to retain the full increase that OMB had approved. However, it should be noted that, although less than we desire, the total funding NASA has been able to allocate for facilities maintenance has grown progressively from $154 million in FY 1989 to $229 million in FY 1992 as a direct result of these focused efforts.

During 1989 and 1990, we conducted an agency-wide review and study of the overall effectiveness and adequacy of our facilities maintenance programs. The study was carried out by a small NASA in-house team of experienced facilities maintenance managers augmented by a specialized technical support contractor to help better determine the current levels of maintenance funding, current facility conditions, and assess the needs for increased funding. The year-long review and study confirmed the high priority for funding within NASA's budget to adequately maintain and preserve the capabilities of the NASA physical plant.

One of the generally accepted guidelines or standards used in assessing the required maintenance funding level is the National Research Council's Building Research Board study recommendation that an appropriate level of maintenance and repair spending should be, on the average, in the range of 2 to 4 percent of the current replacement value of the inventory. The NASA budgets for facilities maintenance and minor repair projects in FY 1991 and FY 1992 currently are within the lower end of that 2 to 4 percent range and our objective is to ramp up our funding levels to the 3 to 3.5 percent range over the next 3 to 4 years.

A recent GAO study confirmed our concerns that have been expressed over the past few years. They also concluded that increased funding was required to bring the NASA maintenance program up to a minimum level. We support the general conclusions of that study and it is consistent with the actions we are taking.

In the interest of precluding possible misunderstandings regarding our facilities maintenance activities, it may be helpful for me to briefly outline the NASA organizational structure and operational procedures:

In view of the fact that facilities maintenance functions consist largely and primarily of the recurring day-to-day broad range of work required to keep both institutional and programmatic facilities in useable operating condition, this activity is budgeted and funded from all the major NASA operating appropriations. These appropriations are the Research and Program Management (R&PM) account, Research and Development (R&D) account, and the Space Flight Control and Data Communications (SFC&DC) account. The Construction of Facilities (CoF) appropriation is a capital investment account that principally funds our new construction, major modifications and repair projects as contrasted to the operating level of effort activities.

To conform with Congressional concerns and guidance concerning appropriations integrity, the R&PM maintenance funds are used primarily for institutional type facilities and the R&D and SFC&DC funds are used mainly for technical and program support facilities. Facilities maintenance funds are budgeted and allocated to the Field Centers by their respective NASA HQs Institutional and Program Offices. These are the Office of Space Flight; the Office of Aeronautics, Exploration and Technology; the Office of Space Science and Applications, and the Office of Space Operations. The Center Directors, in turn, have the delegated authority and responsibility for executing the maintenance activities within the resources that are provided.

This organizational structure and operating system provides our Field Centers with the necessary latitude and flexibility that is an inherent must for any major research and development organization. The capability to respond to programmatic changes and technical demands or breakthroughs is a necessity that must be retained at the operating field level. It is particularly important that we remember that while overall maintenance funding can be compared to a percentage of acquisitions cost, particular individual costs will vary by large amounts, depending on history, use, and many other factors which must be left to local management to evaluate.

Summary

Mr. Chairman, I want to reassure you that we recognize that our unique NASA facilities are national resources, and that we have embarked on a new long-term initiative to improve and increase the maintenance of these valuable assets. The increased funding allocated for this purpose in FY 1991 and FY 1992 is indicative of our focused efforts to do this.

It is also important to note that in parallel with the efforts to increase the level of maintenance activities, NASA has consistently increased the emphasis on major Restoration and Modernization projects in the Construction of Facilities budgets beginning in FY 1989. I am sure that this Subcommittee is familiar with the Aeronautical Facilities Revitalization program which is a major element of our overall restoration and modernization efforts. This aeronautics element is budgeted over a 5 year span at an estimated cost of approximately $300 million and is well along in the construction phase.

Mr. Chairman, this concludes my prepared remarks and I would be pleased to respond to your questions and those of the other Members of the Subcommittee.

Mr. VALENTINE. Thank you, sir.

Mr. Keller, in Admiral Truly's letter dated February 3, 1991, to Chairman Brown concerning this issue of facility maintenance, the Admiral said "The condition of NASA's facilities has resulted from a large number of isolated, independent judgments to defer individual maintenance actions." Who is in charge of maintenance at NASA? Who is accountable for these deferrals, and why were they made?

Mr. KELLER. Mr. Chairman, I think the best way to describe the chain of command at NASA would be to say that it is fairly analogous to a military chain of command. We have in the first instance the field center directors, who have the on-the-spot authority and responsibility to carry out maintenance. They report—and this is a change which Admiral Truly has emphasized since he has become administrator — they report to institutional associate administrators. There are three of those who are responsible in their various ways for the nine field centers within NASA.

The institutional administrators in turn report to the Administrator. All of them are advised by General McGarvey's office, which provides technical expertise to ensure that there is integrity in the review of that system.

To go back to the comment you quoted, I certainly would agree with Admiral Truly's comments that the state of our maintenance at the present time is the result of a large number of independent decisions that have been made over the years. In every case, the field center directors in the first instance have been required to take the available funding they have and address a number of varying situations that will be different in different centers, and apply what has been very limited funding to a number of problems.

That has resulted in individual decisions that have been made. However, we believe they have been made consistent with the overall policy that has been laid down. We recognize, as does the General Accounting Office in their recent survey, that the procedures that we have used have not, in the past, been as precise as possible. We are in the process of correcting those procedures to ensure that in the future, we have both precise guidelines and precise measurement techniques.

But your statement is certainly a correct one, sir, and if you go back and look over the history of the past half a dozen or so years, there have been many decisions that have been made by the various appropriate managers, and they collectively have us in the position we are now in.

Mr. VALENTINE. For the record, this type of maintenance we are talking about is not the sophisticated machinery and apparatus, we are talking about leaks in the roofs of the building, and painting, that sort of thing, aren't we?

Mr. KELLER. No, sir. We are talking about all kinds of things. It runs from leaks in the roof, leaky pipes, to the maintenance of some of the more sophisticated facilities that we have. Typically, if you refer back to the comments I made earlier, the institutional items—the buildings, the roofs, things like that—are generally paid for out of the research and program management appropriation. You will find that the maintenance of the sophisticated technical facilities is generally paid for out of either the research and development or the SFC&DC accounts.

Mr. **Valentine**. Also, going back to the Admiral's letter to Chairman Brown, he said "NASA is currently developing a comprehensive agency manual on facilities maintenance management, which will detail the planning, the programming, budgeting and implementation and control of all facilities maintenance activities at NASA centers." How long has NASA operated without such a policy?

Mr. **Keller**. Mr. Chairman, we have had in place a number of policies over the years. For example, this is the cover of an operations and managers maintenance guide, of which the actual document is about three quarters of an inch thick. That has been in place for over a decade. I think Admiral Truly recognizes that the performance we have gotten from our maintenance program in the past has not been as good as we want and as the country desires and deserves. He is taking steps to ensure that these procedures are updated, made current, and are more precise to ensure that we get improved performance in this area.

Mr. **Valentine**. In the future, there will supposedly be some person other than the Administrator himself who has responsibility, a person we can ask to come and talk to us, and will be charged with the responsibility of seeing that these procedures are carried out?

Mr. **Keller**. That person may very probably be myself. I would make this comment, though, Mr. Chairman, that we have given a lot of attention to how we manage the agency, particularly since Admiral Truly has taken on his present role. With his background of many, many years in the Agency, and his experience in a NASA field center, we have been very careful to try to clean up the lines of management.

One of those changes was to emphasize the role of the institutional associate administrator. We have tried to reduce the influence of staff functions in terms of exercising management authority and put in place a line management structure where individuals are clearly accountable for how the work is performed and what is done.

In the course of creating that structure, we tried to make sure that the lines from center directors through the institutional associate administrators to the Administrator are very clean. I have responsibility for the institutional activities of the Agency in the Office of Administrator. I think I would have to say that if you want a person, I am the one you will call back and ask to give an explanation.

We have not, however, put in place a maintenance czar, because we believe that to do that would dilute the command structure that has been established.

Mr. **Valentine**. Mr. Lewis?

Mr. **Lewis**. Thank you, Mr. Chairman.

Mr. Keller, the GAO report that I am sure you are familiar with points out historically that NASA centers have not based their maintenance budgets on actual need. Hearing your responses to the Chairman that we are going to see some changes in this between 1985 and 1989 with the exception of the jet propulsion laboratory centers, there was only allocated 0.9 to 1.5 percent of the National Research Council's recommendation that the minimum be spent on facility maintenance should be 2.4 percent of a replacement value. You are now saying you are about 2 percent?

Mr. **Keller**. Yes, sir, I believe we are in the 2 percent range. We are a little over 2 percent right now. When you look at the definition used by the academy organization, the NRC organization, they actually define that 2 to 4 percent as including maintenance and repair. When you put those two numbers together, we are somewhat above the 2 percent. We are certainly not as high as we believe we should be.

I think the problem is further exacerbated by the fact that we are somewhat behind to begin with. Probably for a period of time, if we only proceed at the 2 to 4 percent range, we are not going to do much catching up. We recognize that we need to do the catching up, and that will take some doing.

Mr. **Lewis**. I guess I am just slightly confused. If you want to catch up, and it is going to cost much more than 2 percent, but you say you are not quite at 2 percent right now, how do you intend to catch up?

Mr. **Keller**. I think we are a little above 2 percent now. We are trying to get to 3 1/2 percent, and we expect to do that within the next few years.

Mr. **Lewis**. Well, I guess rather than talking about percentages, would you provide the subcommittee with the actual budgets for the percentages for Lewis, Ames, and Langley, and what your increases are going to be over those maintenance funding levels for 1992, what the increases will be over 1991?

Mr. **Keller**. Yes, sir, I will be glad to do that.

Mr. **Lewis**. The GAO report also concluded that the accounting and budgeting systems did not provide complete and accurate data on facility maintenance costs, meaning NASA's. Is this correct?

Mr. **Keller**. Yes, sir, I believe that is correct.

Mr. **Lewis**. Weren't you interested in this? How could you historically establish a maintenance budget if you didn't have this information?

Mr. **Keller**. We have not, in the past, produced what I think you describe as a maintenance budget. That is for several reasons. First of all, there is a maintenance budget.

Mr. **Lewis**. What do you call it, if you don't call it a maintenance budget?

Mr. **Keller**. If I may explain, sir, we do have a maintenance budget in the research and program management account. In the case of the research and development accounts, maintenance is charged back to a particular line item in accordance with how a particular facility may be used in the course of a year.

In the sense of budgeting by line item in individual accounts, we often do not know at the beginning of a year that a particular program will use a particular facility by a certain amount. Because of the requirement to maintain funding integrity, we have not been able to tell people how our maintenance estimates would be. We have not prepared a budget in the sense that we have identified the line items from which the monies would be obtained.

As a practical matter, the way our budgets are put together, it is an iterative process that stretches over a period of some months. The centers will put together their estimates of what it takes to run the organization in the course of the year. That will cover maintenance and a myriad of other items.

We then go through a series of reviews in NASA headquarters. We go through the OMB, and ultimately through the Congress. Typically, in the course of this action, what starts out to be a very adequate number gradually becomes smaller and smaller. As the Center managers deal with these numbers, they constantly revise their budget, and they have to make it fit the number they have. In the course of doing that, what started out to be a requirements budget becomes an exercise in trading off priorities and fitting within the constraints that are imposed upon the system.

For that reason, it is a little difficult to find the maintenance budget in the final product.

Mr. **Lewis**. Mr. Keller, I had to keep NASA budgets as well as company budgets. If I just gave that explanation to my boss that you gave to me, he would have fired me. I am sorry I have to say that. I would like for you to provide the subcommittee with the total maintenance budget at Lewis, Ames and Langley and give us a detailed listing, if you would, please.

Mr. **Keller**. We will provide you the budgets we have, sir.

Mr. **Lewis**. Pardon?

Mr. **Keller**. We will provide you with the budgets we have.

Mr. **Lewis**. I have no further questions.

Mr. **Valentine**. Mr. Bacchus?

Mr. **Bacchus**. Thank you, sir.

Mr. Keller, I come from Central Florida, that includes the Kennedy Space Center. First of all, I want to echo the Chairman's concern about accountability. When it comes to maintenance the buck seems to stop many places in NASA. I think it should stop in one place, as my colleagues do.

I have a couple of specific concerns. One won't surprise you. What about the leaky roof on the vehicle assembly building? I was down there a few weeks ago. From the outside, we see this marvelous masterpiece of American technology, the showcase of the American space program. We go inside this 52-story building and we look up and there are nets right beneath the roof that are keeping concrete chips from falling on the workers below because of the leaky roof.

Where are we in terms of repairing that?

Mr. **Keller**. Right now, Mr. Bacchus, we are in the process of replacing that roof. I believe that is a Construction of Facilities item in the order of approximately $10 million. When that is completed, the nets will be removed and the problem should be solved.

Mr. **Bacchus**. When do you estimate that will be completed?

Mr. **Keller**. Sir, it is underway. It has a 14-month cycle to completion.

Mr. **Bacchus**. I understand there are some technical hurdles to overcome in terms of getting up there 52 stories to repair the roof, so I understand that it does take longer than it might on my house.

Mr. **Keller**. Let me see if General McGarvey can give you specific information on that project.

General McGarvey. Mr. Bacchus, it is about an $11 million repair project, a major repair project, which includes repairs of the roof structure itself. It also includes a false metal roof underneath in the event there is any falling of concrete, after we dry out the upper roof and replace the areas that need to be replaced. It has about a 14-month completion period. We have to schedule it around the operations within the building itself, to be sure we don't create additional hazards while there are stacking and mating operations of the solid rocket motors with the orbiter underneath.

At the same time, as you say it is 52 stories in the air, and there is a layer of asbestos material in the upper layers of it which causes some protective problems we have to deal with, and that extends the time period to complete the overall project.

Mr. Bacchus. Mr. Chairman, may I ask one more quick question?

If you have been to Kennedy and seen the trailers, there are trailers there. If you work in one of these trailers, you have to go elsewhere to go to the restroom. We have some of our best scientists, engineers and technicians working there. We heard testimony this morning about the need for more engineers in America. We have heard repeated testimony about the need to keep more of our good engineers and scientists in NASA. Part of that is money, but part of it is also working conditions. These trailers were put there temporarily, at the outset of the space program three decades ago. They are still there and we are still using them. What are the prospects of replacing them, and getting better working conditions for our workers at NASA?

Mr. Keller. We have had underway for the last few years a program to try to justify additional people-housing facilities throughout the agency. You are certainly correct in observing the shortage at the Kennedy Space Center. There are similar shortages at many of our other centers.

At the present time, within the budget constraints that exist, we have not been able to bring people-housing buildings to a priority level that has enabled us to justify their inclusion in the budget. We have been faced with numerous programmatic problems, one of which is again in the nature of maintenance, where we have in the last few years gone out and put a major program in place to rehabilitate our wind tunnels. These kinds of activities have precluded what we recognize is a needed requirement for space to put people in. We would like to do that as soon as possible.

Mr. Bacchus. I certainly understand the question of priorities. I realize these are not the most glamorous aspects of the space program, but I do think this is significant, and I encourage you to continue to work your way within the internal bureaucracy as you prepare next year's budget to try to move this up the ladder.

Thank you, Mr. Chairman.

Mr. Valentine. Thank you, sir.

Let me say, Mr. Keller, and to all of you, that this is a serious matter. You understand that from the questions asked. Nobody wants to get into—at least most of us—don't want to get into anything that is unpleasant.

But it is a situation that we intend to pursue insofar as the jurisdiction of this subcommittee will allow it, and also to contact the ultimate appropriate subcommittees in the Congress to see if we can't bring enough light to bear on this problem to get it corrected before something drastic occurs, either in the Agency or instigated by members of Congress.

It does strike us as indefensible that the taxpayers— generously and with a great deal of pride—have laid out so much money over the years to maintain this program and to find out that for whatever reason, the roofs leak and they don't get patched. Is that a flat-top building?

General McGarvey. Yes.

Mr. Valentine. Why do we keep on building them? I used to represent, in my other life, a board of education. I'll bet that 95 percent of the public schools that have been built in this country in the past 50 years were built with flat roofs. They always leak. They always leak. You can look down on these buildings from any perch around, the flat top buildings, and when it rains, the water puddles on top of it.

I don't know why in the name of all that's holy we keep on building retaining walls so that the deposit of water and snow can just sit there and seep through the cracks.

Does anybody else have anything they want to offer for the good of the order?

Thank all of you. This concludes the hearing. Let me announce before we depart that the next hearing of the subcommittee will be in this room, on Thursday, March 7, beginning at 9:30 a.m. on the question of high performance computing.

[Whereupon, at 11:31 a.m., the subcommittee recessed, to reconvene at 9:30 a.m. on

APPENDIX I

MATERIAL SUBMITTED FOR THE RECORD

HON. TOM LEWIS (R-FL)

STATEMENT FOR THE RECORD

TECHNOLOGY AND COMPETITIVENESS HEARING

ON NASA AERONAUTICS AUTHORIZATION

MARCH 5, 1991

Thank you Mr. Chairman.

Again this year I am pleased to see the President's budget request for NASA aeronautical research and technology above last year's appropriations level. In fact, the $591 million for research and technology represents a 15 percent increase.

The increase is for program growth rather than new starts. I am delighted to see this support for ongoing research. This is a management philosophy that will insure the research program will produce the maximum results for many years.

This Subcommittee, Technology and Competitiveness, has a renewed interest in the NASA aeronautical programs that strengthen the U.S. economic base.

For example, the U.S. aerospace industry had a positive balance of trade of $25 billion in 1990. That is the largest of any sector. That is due in part to U.S. technological superiority which is the direct result of long-term, high risk research programs such as the NASA aeronautical research effort.

The struggle to get this recognition within the Administration has been a long one but finally, the President's budget request reflects a significant increase which Congress has approved.

Nevertheless, in order to maintain U.S. technology superiority, it is important that an aggressive research program be maintained. The budget request before us is both aggressive and responsible.

I look forward to hearing today's witnesses comment on the strengths and weaknesses of the NASA aeronautics budget request for Fiscal Year 1992.

Thank you Mr. Chairman.

NASA
National Aeronautics and
Space Administration
Washington, D.C.
20546

MAR 14 1991

Reply to Attn of LB:MDK:map:L90-02511f

The Honorable Tim Valentine
Chairman
Subcommittee on Technology and
Competitiveness
Committee on Science, Space
and Technology
House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

Enclosed are the final responses to written questions submitted by the Subommittee with respect to NASA's FY 1992 budget request for Aeronautics and Transatmospheric Research and Technology.

Sincerely,

Mary D. Kerwin
Director,
Congressional Liaison Division

Enclosure

QUESTION 1:

Please tabulate the FY 1991 Operating Plan for Aeronautics R&T and Transatmospheric R&T, explaining any changes from the initial plan (budget request).

QUESTION 1:

Please tabulate the FY 1991 Operating Plan for Aeronautics R&T and Transatmospheric R&T, explaining any changes from the initial plan (budget request).

ANSWER 1:

The requested information is tabulated below:

	FY 1991
Aeronautics R&T	
FY 1991 Budget Estimate	$ 512,000,000
Current Estimate	$ 512,000,000

The total funding for the Aeronautics R&T program has not changed; however, as a result of Congressional action on the FY 1991 budget request, a total of $17.0 million was reallocated from the R&T Base to Systems Technology to support the High-Performance Computing program. Specific actions to accommodate this reallocation are dis- cussed in the statements which follow.

Transatmospheric R&T

FY 1991 Budget Estimate	$119,000,000
Congressional Reduction	- 24,000,000
Current Estimate	$ 95,000,000

QUESTION 2:

Please tabulate for fiscal year 1990 through 1994 costs of the Aeronautics R&T program (broken out in the following categories: Transport, General Aviation/Commuter, Rotorcraft, High Performance, Supersonic, Hypersonic, and Generic R&T). Also, to permit relating this to the standard budget sublines, please provide a further breakout, for each category, showing funds included in the R&T base, and the various Systems Technology Programs identified by budget sub-line item and further identified by program (e.g. Advanced Propulsion Systems, Technology under Transport, and ATF under Advanced Propulsion Systems Technology).

ANSWER 2:

The enclosed table contains information in the following categories:

Subsonic Aircraft
Rotorcraft
High Performance Aircraft
Supersonic Cruise
Hypersonic/Transatmospheric Technology
Transatmospheric R&T
Generic

This vertical-cut data is not representative of the level of technology being addressed by the Aeronautics program in the indicated vehicle classes. The fundamental nature of the Aeronautics research and Technology program is, in most instances, synergistic (i.e., applicable to more than one speed regime), but we have attempted to provide a nonsynergistic vertical cut of the Aeronautics R&T program as requested.

AERONAUTICAL RESEARCH AND TECHNOLOGY
SPECIAL ANALYSIS
(Real Year $ in Millions)

	FY 90	FY 91	FY 92	FY 93	FY 94
SUBSONIC AIRCRAFT	83.4	96.8	104.4	111.0	120.1
RESEARCH & TECHNOLOGY BASE	51.5	51.8	54.0	57.7	59.7
AERODYNAMICS	8.6	9.6	10.1	11.3	11.5
PROPULSION & POWER	9.8	10.3	11.8	12.4	12.9
MATERIALS & STRUCTURES	3.2	3.0	3.1	3.3	3.4
CONTROLS, GUIDANCE & HUMAN FACTORS	27.0	25.7	25.9	27.4	28.4
FLIGHT SYSTEMS	2.4	2.5	2.7	2.8	3.0
SYSTEMS ANALYSIS	0.5	0.7	0.4	0.5	0.5
ADVANCED PROPULSION SYSTEMS TECHNOLOGY	13.1	15.0	15.4	16.0	16.4
ADVANCED TURBOPROP SYSTEMS	10.3	12.1	12.4	12.9	13.2
GENERAL AVIATION/COMMUTER ENGINE TECH.	2.8	2.9	3.0	3.1	3.2
MATERIALS & STRUCTURES SYSTEMS TECH.	18.8	30.0	30.0	25.0	25.6
ADVANCED COMPOSITE MATERIALS TECH.	18.8	30.0	30.0	25.0	25.6
ADVANCED SUBSONIC TECHNOLOGY	--	--	5.0	12.3	18.4
ROTORCRAFT	21.7	24.3	25.3	27.4	28.0
RESEARCH & TECHNOLOGY BASE	18.1	19.2	20.1	22.0	22.5
AERODYNAMICS	10.8	12.1	12.8	14.3	14.5
MATERIALS & STRUCTURES	3.8	3.5	3.6	3.8	4.0
CONTROLS, GUIDANCE & HUMAN FACTORS	2.8	2.7	2.9	3.0	3.1
SYSTEMS ANALYSIS	0.7	0.9	0.8	0.9	0.9
ROTORCRAFT SYSTEMS TECHNOLOGY	3.6	5.1	5.2	5.4	5.5
ADVANCED ROTORCRAFT TECHNOLOGY	3.6	5.1	5.2	5.4	5.5
HIGH-PERFORMANCE AIRCRAFT	110.8	118.4	126.9	132.5	134.6
RESEARCH & TECHNOLOGY BASE	101.1	107.9	115.8	120.6	122.4
AERODYNAMICS	36.3	40.5	40.3	43.3	42.4
PROPULSION & POWER	24.2	25.6	29.2	29.7	30.0
MATERIALS & STRUCTURES	2.5	2.3	2.3	2.3	2.3
CONTROLS, GUIDANCE & HUMAN FACTORS	6.8	6.5	6.8	7.0	7.0
FLIGHT SYSTEMS	31.3	33.0	33.7	35.1	36.1
SYSTEMS ANALYSIS	--	--	3.5	3.2	4.6
HIGH-PERFORMANCE AIRCRAFT SYSTEMS TECH.	9.7	10.5	11.1	11.9	12.2
HIGH-PERFORMANCE FLIGHT RESEARCH	9.7	10.5	11.1	11.9	12.2
SUPERSONIC CRUISE	39.7	59.8	94.3	109.0	110.3
RESEARCH & TECHNOLOGY BASE	15.2	15.8	17.9	19.1	19.9
AERODYNAMICS	2.1	2.3	2.8	3.2	3.2
PROPULSION & POWER	9.2	9.7	11.1	11.7	12.3
MATERIALS & STRUCTURES	3.2	3.0	3.1	3.3	3.4
CONTROLS, GUIDANCE & HUMAN FACTORS	0.3	0.3	0.3	0.3	0.3
SYSTEMS ANALYSIS	0.4	0.5	0.6	0.6	0.7
HIGH-SPEED RESEARCH	24.5	44.0	76.4	89.9	90.4
ATMOSPHERIC EFFECTS	6.1	12.0	12.0	12.0	11.0
EMISSIONS AND SOURCE NOISE	12.6	20.3	30.1	28.6	24.8
COMMUNITY NOISE AND SONIC BOOM	5.8	11.7	17.8	17.3	14.1
ENABLING PROPULSION MATERIALS	--	--	16.5	32.0	40.5
HYPERSONIC/TRANSATMOSPHERIC TECH.	25.2	27.0	29.2	31.3	32.2
RESEARCH & TECHNOLOGY BASE	25.2	27.0	29.2	31.3	32.2
AERODYNAMICS	11.0	12.3	13.1	14.5	14.7
PROPULSION & POWER	7.3	7.7	8.9	9.2	9.7
MATERIALS & STRUCTURES	3.3	3.1	3.2	3.4	3.5
CONTROLS, GUIDANCE & HUMAN FACTORS	2.1	2.0	2.2	2.4	2.4
SYSTEMS ANALYSIS	1.5	1.9	1.8	1.8	1.9
TRANSATMOSPHERIC R&T (NON ADD)	(80.0)	(95.0)	(72.0)	(120.0)	(145.0)

	FY 90	FY 91	FY 92	FY 93	FY 94
GENERIC	161.8	185.7	211.1	259.3	290.8
RESEARCH & TECHNOLOGY BASE	110.7	114.7	138.6	152.8	159.0
AERODYNAMICS	35.6	39.7	49.2	55.9	57.8
PROPULSION & POWER	17.4	18.4	23.1	25.3	27.1
MATERIALS & STRUCTURES	24.1	22.3	27.5	29.3	30.6
CONTROLS, GUIDANCE & HUMAN FACTORS	24.2	23.1	29.5	31.4	33.2
FLIGHT SYSTEMS	4.6	4.9	5.7	6.7	7.2
SYSTEMS ANALYSIS	4.8	6.3	3.6	4.2	3.1
NUMERICAL AERODYNAMIC SIMULATION	41.8	44.1	45.4	47.0	48.1
NUMERICAL AERODYNAMIC SIMULATION	27.8	29.6	30.5	31.5	32.2
NAS OPERATIONS	14.0	14.5	14.9	15.5	15.9
MATERIALS & STRUCTURES SYSTEMS TECH.	9.3	9.9	10.1	10.5	10.7
ADV. HIGH-TEMP. ENGINE MAT'LS. TECH.	9.3	9.9	10.1	10.5	10.7
HIGH-PERFORMANCE COMPUTING	(2.0) *	17.0	17.0	49.0	73.0
COMPUTATIONAL AEROSCIENCES	--	17.0	10.4	32.2	43.4
EARTH AND SPACE SCIENCES	--	--	5.5	15.1	24.0
REMOTE EXPLORATION & EXPERIMENTATION	--	--	1.1	1.7	5.6
TOTAL	442.6	512.0	591.2	670.5	716.0

* In FY 1991, $2.0M was earmarked within the research and technology base program for the High-Performance Computing Initiative.

QUESTION 3:

Please provide a tabulation for each Systems Technology project where funds are requested for FY 1992 and where total anticipated costs exceed $50 million and for Transatmospheric R&T showing:

a. Original estimated date of completion and costs; b. Estimated date and cost of completion furnished to the Subcommittee last year; c. Current estimates; d. Reasons for change from last year.

QUESTION 3:

Please provide a tabulation for each Systems Technology project where funds are requested for FY 1992 and where total anticipated costs exceed $50 million and for Transatmospheric R&T showing:

a. Original estimated date of completion and costs;
b. Estimated date and cost of completion furnished to the Subcommittee last year;
c. Current estimates;
d. Reasons for change from last year.

ANSWER:

(Dollars in Millions)

High-Speed Research

	ORIGINAL ESTIMATE	JANUARY 1990 ESTIMATE	CURRENT ESTIMATE
Date of Completion	1995	1995	1998
Cost	284.0	283.5	407.5

Reason for Change from Last Year: The increase reflects the addition of a new element in enabling propulsion materials, beginning in FY 1992.

High-Performance Computing

	ORIGINAL ESTIMATE	JANUARY 1990 ESTIMATE	CURRENT ESTIMATE
Date of Completion	--	--	2000
Cost			680.0

Reason for Change from Last Year: This is the NASA portion of the federal program in High-Performance Computing and Communications, beginning in FY 1992.

Advanced Subsonic Technology

	ORIGINAL ESTIMATE	JANUARY 1990 ESTIMATE	CURRENT ESTIMATE
Date of Completion	--	--	1998
Cost			120.0

Reason for Change from Last Year: This program is being initiated in FY 1992.

National Aero-Space Plane Program

	ORIGINAL ESTIMATE	JANUARY 1990 ESTIMATE	CURRENT ESTIMATE
Date of Completion	1993	1996	TBD
Cost	597.0	699.7	TBD
Transatmospheric R&T	(443.0)	(629.9)	(TBD)
Aeronautics and Space R&T Base	(154.0)	(69.8)	(69.8)

Reason for Change from Last Year: The current phase (Phase 2) was extended to the Spring of 1993 at the direction of the National Space Council and the President. At that time a decision will be made as to whether to proceed to Phase 3 (the design, development and flight test of an X-30 flight research vehicle) based on program status and an accurate determination of cost.

QUESTION 4:

Please provide quantitative data that traces the development of the FY 1992 budget request for Aeronautics and Transatmospheric. Specifically, please show initial and final OAET recommendations, submission to OMB and the request to Congress for new initiatives.

QUESTION 4:

Please provide quantitative data that traces the development of the FY 1992 budget request for Aeronautics and Transatmospheric. Specifically, please show initial and final OAET recommendations, submission to OMB and the request to Congress for new initiatives.

ANSWER 4:

	RECOMMENDATION TO ADMINISTRATOR	SUBMISSION TO OMB	SUBMISSION TO CONGRESS
		(Dollars in Millions)	
AERONAUTICS R&T	614.5	603.0	591.2
Ongoing Baseline	554.5	554.5	552.7
Program Augmentations/Initiatives	60.0	48.5	38.5
Enabling Propulsion Materials	18.0	16.5	16.5
Advanced Subsonic Technology	25.0	15.0	5.0
High-Performance Computing	17.0	17.0	17.0
TRANSATMOSPHERIC R&T	72.0	72.0	72.0

QUESTION 5:

Please provide the budget "levels" (e.g., ongoing, baseline adjustments and augmentations) broken out by standard budget sub-line item, as pre- sented in the R&D budget book for fiscal year 1992 through 1996 for the OAET recommendation, submission to OMB and the request to Congress for Aeronautics R&T and Transatmospheric R&T. For Systems Technology programs, please provide figures for one budget level below the sub-line item. Also, please provide brief descriptions of the work in each level. For the request to Congress, please provide cumulative prior year funding for Systems Technology programs.

FY 1992 RECOMMENDATION TO ADMINISTRATOR

(Dollars in Millions)

	FY 92	FY 93	FY 94	FY 95	FY 96
AERONAUTICAL R&T	614.5	713.8	776.6	811.4	731.2
Research and Technology Base	377.3	401.3	411.7	432.6	413.6
Aerodynamics R&T	124.4	133.7	137.3	144.4	131.5
Propulsion & Power R&T	84.7	91.6	94.2	99.0	87.7
Materials & Structures R&T	44.0	45.9	47.0	49.3	51.5
Controls, Guidance and Human Factors R&T	68.2	71.7	73.5	77.2	77.4
Flight Systems R&T	42.6	44.4	45.4	47.7	49.8
Systems Analysis	13.4	14.0	14.3	15.0	15.7

Description: Basic and applied discipline and systems research and technology.

	FY 92	FY 93	FY 94	FY 95	FY 96
Systems Technology Programs	237.2	312.5	364.9	378.8	317.6
High-Performance Computing	17.0	49.0	73.0	87.0	79.0

Description: This program was to accelerate the availability of high-performance computing technologies for NASA's science and engineering needs; enable teraflops computer capabilities essential for computational design of aerospace vehicle systems and for predicting long-term global change; and provide a thousand-fold increase in computational capabilities for spaceborne applications by the late 1990's.

	FY 92	FY 93	FY 94	FY 95	FY 96
Materials and Structures Sys. Tech.	40.1	35.5	36.3	38.1	39.8
Advanced High-Temperature Engine Materials Technology	10.1	10.5	10.7	11.2	11.7

Description: The objective of this program is to develop technology for revolutionary advances in materials to enable development of 21st century aircraft propulsion systems.

	FY 92	FY 93	FY 94	FY 95	FY 96
Advanced Composite Materials Technology	30.0	25.0	25.6	26.9	28.1

Description: This program concentrates on developing advanced materials and innovative structural concepts to fully exploit the benefits to composite materials for cost-effective primary structures for future aircraft applications.

	FY 92	FY 93	FY 94	FY 95	FY 96
Rotorcraft Systems Technology	5.2	5.4	5.5	5.8	6.1
Advanced Rotorcraft Technology	5.2	5.4	5.5	5.8	6.1

Description: This program is focused on noise reduction and technology for high-speed rotorcraft.

RECOMMENDATION TO ADMINISTRATOR (CONTINUED)

	FY 92	FY 93	FY 94	FY 95	FY 96
High-Performance Aircraft Systems Technology	11.1	11.9	12.2	12.8	13.4
High-Performance Flight Research	11.1	11.9	12.2	12.8	13.4

Description: This program concentrates on the generation of validated engineering methods and design data applicable to the development of advanced high-performance, high-speed aircraft applications.

	FY 92	FY 93	FY 94	FY 95	FY 96
Advanced Propulsion Systems Tech.	15.4	16.0	16.4	17.3	18.1
Advanced Turboprop Systems	12.4	12.9	13.2	13.9	14.5

Description: Activities in this focused technology program emphasize advanced concepts, acoustics, and installation aerodynamics.

	FY 92	FY 93	FY 94	FY 95	FY 96
General Aviation/Commuter Engine Technology	3.0	3.1	3.2	3.4	3.6

Description: The objective of this program is to raise the performance level of small turbine engines to approximately that of large transport turbine engines with a decrease in fuel consumption of 30 percent.

	FY 92	FY 93	FY 94	FY 95	FY 96
Numerical Aerodynamic Simulation	45.4	47.0	48.1	50.5	52.7
Numerical Aerodynamic Simulation	30.5	31.5	32.2	33.8	35.3
NAS Operations	14.9	15.5	15.9	16.7	17.4

Description: This program is designed to significantly augment the nation's capabilities in computational fluid dynamics and other areas of computational physics by developing a preeminent capability for numerical simulation of aerodynamic flows.

	FY 92	FY 93	FY 94	FY 95	FY 96
High-Speed Research	78.0	90.8	97.0	89.0	32.0
Atmospheric Effects	12.0	12.0	11.0	11.0	--

Description: This effort includes theoretical and experimental research to assess the effects of stratospheric aircraft, including depletion of ozone, perturbations to atmospheric chemistry on a global scale, and the potential for long-term climate change.

	FY 92	FY 93	FY 94	FY 95	FY 96
Emissions and Source Noise	30.1	28.6	24.8	22.8	--

Description: The objective of this activity is to explore advanced concepts in emissions and source noise and to develop component level technologies that lead to nitrous oxide levels compatible with the stratospheric ozone layer and noise levels that comply with the current standard (FAR 36, Stage III).

FY 1992 SUBMISSION TO OMB
(Dollars in Millions)

	FY 92	FY 93	FY 94	FY 95	FY 96
AERONAUTICAL R&T	603.0	708.9	784.1	828.4	751.6
Research and Technology Base	377.3	401.3	411.7	432.6	413.6
Aerodynamics R&T	124.4	133.7	137.3	144.4	131.5
Propulsion & Power R&T	84.7	91.6	94.2	99.0	87.7
Materials & Structures R&T	44.0	45.9	47.0	49.3	51.5
Controls, Guidance and Human Factors R&T	68.2	71.7	73.5	77.2	77.4
Flight Systems R&T	42.6	44.4	45.4	47.7	49.8
Systems Analysis	13.4	14.0	14.3	15.0	15.7

Description: Basic and applied discipline and systems research and technology.

Systems Technology Programs	225.7	307.6	372.4	395.8	338.0
High-Performance Computing	17.0	49.0	73.0	87.0	79.0

Description: This program was to accelerate the availability of high-performance computing technologies for NASA's science and engineering needs; enable teraflops computer capabilities essential for computational design of aerospace vehicle systems and for predicting long-term global change; and provide a thousand-fold increase in computational capabilities for spaceborne applications by the late 1990's.

Materials and Structures Sys. Tech.	40.1	35.5	36.3	38.1	39.8
Advanced High-Temperature Engine Materials Technology	10.1	10.5	10.7	11.2	11.7

Description: The objective of this program is to develop technology for revolutionary advances in materials to enable development of 21st century aircraft propulsion systems.

Advanced Composite Materials Technology	30.0	25.0	25.6	26.9	28.1

Description: This program concentrates on developing advanced materials and innovative structural concepts to fully exploit the benefits to composite materials for cost-effective primary structures for future aircraft applications.

Rotorcraft Systems Technology	5.2	5.4	5.5	5.8	6.1
Advanced Rotorcraft Technology	5.2	5.4	5.5	5.8	6.1

Description: This program is focused on noise reduction and technology for high-speed rotorcraft.

SUBMISSION TO OMB (CONTINUED)

	FY 92	FY 93	FY 94	FY 95	FY 96
High-Performance Aircraft Systems Technology	11.1	11.9	12.2	12.8	13.4
High-Performance Flight Research	11.1	11.9	12.2	12.8	13.4

Description: This program concentrates on the generation of validated engineering methods and design data applicable to the development of advanced high-performance, high-speed aircraft applications.

Advanced Propulsion Systems Tech.	15.4	16.0	16.4	17.3	18.1
Advanced Turboprop Systems	12.4	12.9	13.2	13.9	14.5

Description: Activities in this focused technology program emphasize advanced concepts, acoustics, and installation aerodynamics.

General Aviation/Commuter Engine Technology	3.0	3.1	3.2	3.4	3.6

Description: The objective of this program is to raise the performance level of small turbine engines to approximately that of large transport turbine engines with a decrease in fuel consumption of 30 percent.

Numerical Aerodynamic Simulation	45.4	47.0	48.1	50.5	52.7
Numerical Aerodynamic Simulation	30.5	31.5	32.2	33.8	35.3
NAS Operations	14.9	15.5	15.9	16.7	17.4

Description: This program is designed to significantly augment the nation's capabilities in computational fluid dynamics and other areas of computational physics by developing a preeminent capability for numerical simulation of aerodynamic flows.

High-Speed Research	76.5	97.8	108.5	97.0	40.0
Atmospheric Effects	12.0	12.0	11.0	11.0	--

Description: This effort includes theoretical and experimental research to assess the effects of stratospheric aircraft, including depletion of ozone, perturbations to atmospheric chemistry on a global scale, and the potential for long-term climate change.

Emissions and Source Noise	30.1	28.6	24.8	22.8	--

Description: The objective of this activity is to explore advanced concepts in emissions and source noise and to develop component level technologies that lead to nitrous oxide levels compatible with the stratospheric ozone layer and noise levels that comply with the current standard (FAR 36, Stage III).

FY 1992 SUBMISSION TO CONGRESS
(Dollars in Millions)

	Prior	FY 92	FY 93	FY 94	FY 95	FY 96
AERONAUTICAL R&T		591.2	670.5	716.0	742.6	672.2
Research and Technology Base		375.6	403.5	415.7	435.7	428.6
Aerodynamics R&T		128.3	142.5	144.1	151.2	135.7
Propulsion & Power R&T		84.1	88.3	92.0	96.4	90.7
Materials & Structures R&T		42.8	45.4	47.2	49.4	53.1
Controls, Guidance and Human Factors R&T		67.6	71.5	74.4	78.0	83.8
Flight Systems R&T		42.1	44.6	46.3	48.6	52.2
Systems Analysis		10.7	11.2	11.7	12.1	13.1

Description: Basic and applied discipline and systems research and technology.

Systems Technology Programs		215.6	267.0	300.3	306.9	243.6
High-Performance Computing	17.0	17.0	49.0	73.0	87.0	79.0

Description: The objective of this program is to accelerate the availability of high-performance computing technologies for NASA's science and engineering needs. It will enable teraflops computer capabilities essential for computational design of aerospace vehicle systems and for predicting long-term global change and a thousand-fold increase in computational capabilities for spaceborne applications by the late 1990's.

Materials & Structures Systems Technology		40.1	35.5	36.3	38.1	39.8
Advanced High-Temperature Engine Materials Technology	37.2	10.1	10.5	10.7	11.2	11.7

Description: The objective of this program is to develop technology for revolutionary advances in materials to enable development of 21st century aircraft propulsion systems.

Advanced Composite Materials Technology	58.8	30.0	25.0	25.6	26.9	28.1

Description: This program concentrates on developing advanced materials and innovative structural concepts to fully exploit the benefits to composite materials for cost-effective primary structures for future aircraft applications.

Rotorcraft Systems Technology		5.2	5.4	5.5	5.8	6.1
Advanced Rotorcraft Tech.	88.2	5.2	5.4	5.5	5.8	6.1

Description: This program is focused on noise reduction and technology for high-speed rotorcraft.

SUBMISSION TO CONGRESS (CONTINUED)

	Prior	FY 92	FY 93	FY 94	FY 95	FY 96
High-Performance Aircraft Systems Technology		11.1	11.9	12.2	12.8	13.4
High-Performance Flt. Res.	100.7	11.1	11.9	12.2	12.8	13.4

Description: This program concentrates on the generation of validated engineering methods and design data applicable to the development of advanced high-performance, high-speed aircraft applications.

	Prior	FY 92	FY 93	FY 94	FY 95	FY 96
Advanced Propulsion Systems Tech.		15.4	16.0	16.4	17.3	18.1
Advanced Turboprop Systems	190.2	12.4	12.9	13.2	13.9	14.5

Description: Activities in this focused technology program emphasize advanced concepts, acoustics, and installation aerodynamics.

	Prior	FY 92	FY 93	FY 94	FY 95	FY 96
General Aviation/Commuter Engine Technology	22.6	3.0	3.1	3.2	3.4	3.6

Description: The objective of this program is to raise the performance level of small turbine engines to approximately that of large transport turbine engines with a decrease in fuel consumption of 30 percent.

	Prior	FY 92	FY 93	FY 94	FY 95	FY 96
Numerical Aerodynamic Simulation		45.4	47.0	48.1	50.5	52.7
Numerical Aerodynamic Sim.	210.4	30.5	31.5	32.2	33.8	35.3
NAS Operations	55.3	14.9	15.5	15.9	16.7	17.4

Description: This program is designed to significantly augment the nation's capabilities in computational fluid dynamics and other areas of computational physics by developing a preeminent capability for numerical simulation of aerodynamic flows.

	Prior	FY 92	FY 93	FY 94	FY 95	FY 96
High-Speed Research		76.4	89.9	90.4	70.9	11.0
Atmospheric Effects	18.1	12.0	12.0	11.0	11.0	--

Description: This effort includes theoretical and experimental research to assess the effects of stratospheric aircraft, including depletion of ozone, perturbations to atmospheric chemistry on a global scale, and the potential for long-term climate change.

	Prior	FY 92	FY 93	FY 94	FY 95	FY 96
Emissions and Source Noise	32.9	30.1	28.6	24.8	22.8	--

Description: The objective of this activity is to explore advanced concepts in emissions and source noise and to develop component level technologies that lead to nitrous oxide levels compatible with the stratospheric ozone layer and noise levels that comply with the current standard (FAR 36, Stage III).

SUBMISSION TO CONGRESS (CONTINUED)

High-Speed Research (Cont'd)	Prior	FY 92	FY 93	FY 94	FY 95	FY 96
Community Noise and Sonic Boom	17.5	17.8	17.3	14.1	13.1	--

Description: The objective of this activity is to develop the design methodologies to reduce community noise during takeoff and approach to FAR 36, Stage III, levels and to minimize the impact of sonic boom.

Augmentation:

Enabling Propulsion Materials		16.5	32.0	40.5	24.0	11.0

Description: The objective of this proposed program is to develop advanced high-temperature composite materials and fibers, fabrication methods, and material system performance for applications in high-speed civil transport.

New Initiative:

Advanced Subsonic Technology		5.0	12.3	18.4	24.5	23.5

Description: The objectives of the advanced subsonic technology program are to accelerate the development of nondestructive evaluation technology to ensure the safe operation of aging transport aircraft in the national airspace system and to provide the technology base for confident application and certification of fly-by-light/power-by-wire control systems to civil transport aircraft.

TRANSATMOSPHERIC R&T		72.0	120.0	145.0	175.0	200.0

Description: The National Aero-Space Plane program is a joint effort between NASA and the DOD to accelerate the development of critical enabling technologies for transatmospheric vehicles.

QUESTION 6:

How much is contained in the Fiscal Year 1992 request for alternative fuels utilization research, aircraft noise research, wake vortex alleviation, scarce materials research, human factors, avionics, controls, laminar flow control, university research, ATOPS, wind tunnels and technical facilities, scientific and technical ADP, and aging aircraft and engines. Please estimate the number of university grants and fellowships.

ANSWER 6:

	FY 1992 ($ in Millions)
Alternative fuels utilization research	0 (1)
Aircraft noise research	30.1 (2)
Wake vortex alleviation	0 (3)
Scarce materials research	0
Human factors	13.4
Avionics	0.4
Controls	19.1
Laminar flow control	7.0 (4)
University research	50.6 (5)
ATOPS	4.0
Wind tunnels and technical facilities	130.5 (6)
Scientific and technical ADP	140.8 (7)
Aging aircraft and engines	4.0

(1) General aviation propulsion systems which can utilize alternative fuels (3.1M) and slush hydrogen fuel storage and transfer in NASA-funded portion of the National Aerospace Plane program (3.0M)

(2) Includes $1.0M for fundamental aeroacoustics research, $6.0M for rotorcraft noise research, and $8.0M for advanced ducted propeller source noise, and $15.1M for propulsion source noise of high-speed civil transports.

(3) Fundamental computational and experimental research is being conducted on vortex formation, propagation, interactions, and breakdown -- 1.0M

(4) Includes $2.0M for subsonic hybrid laminar flow control and $5.0M for supersonic laminar flow control.

(5) Estimated number of university grants/fellowships in FY 1992 is 465.

(6) Includes data acquisition and reduction systems which are an inherent part of the wind tunnels and other aeronautical facilities.

(7) Includes the Numerical Aerodynamic Simulation system and other central scientific and technical ADP support, and dedicated distributed ADP.

QUESTION 7:

Please provide graphic data showing the effect of inflation on NASA aeronautical programs since 1981.

ANSWER 7:

The information in graphic form is enclosed. The information is displayed in numerical form below (dollars in millions):

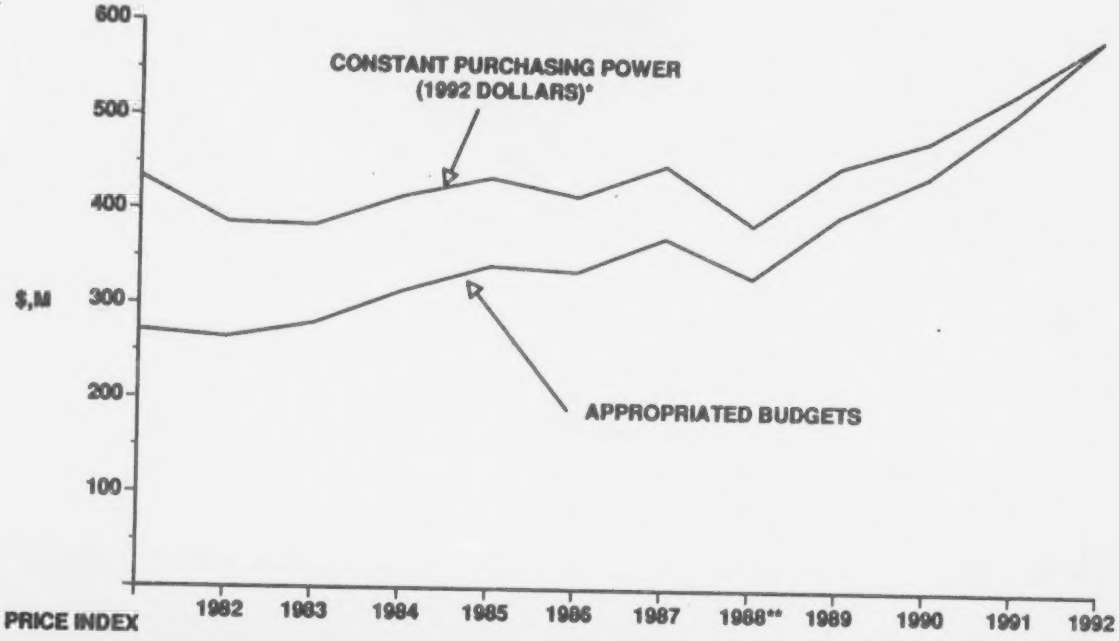
Year	Appropriated Budget	Constant 1992 Dollars (GNP Price Index)
1981	271.4	434.5
1982	264.8	386.6
1983	280.0	384.2
1984	315.3	416.2
1985	342.4	435.9
1986	337.3	416.9
1987	374.0	450.7
1988	332.9*	388.8
1989	400.2	452.2
1990	442.6	480.7
1991	512.0	533.5
1992	591.2	591.2

*In FY 1988, approximately $42 million was transferred from R&D to R&PM as part of the overall agency appropriation integrity transfer.

AERONAUTICS R&T PROGRAM EFFECTS OF INFLATION

ØAET

(1982 - 1992)



* GNP PRICE INDEX

** In FY 1988, approximately $42 million was transferred from R&D to R&PM as part of the overall agency appropriation integrity transfer.

QUESTION 8:

Please characterize the major changes (new initiatives, reprogramming, inflation, etc.) in the R&T Base and Systems Technology from FY 91 to FY 92.

ANSWER 8:

In addition to inflation, the R&T Base reflects planned growth in facility maintenance and instrumentation. In FY 1991, $17.0 million of baseline support in information sciences and computational activities was deferred, since the funds were reallocated from the R&T Base to the Systems Technology area to support high-performance computing. These baseline activities will be resumed in FY 1992.

The FY 1992 Systems Technology programs reflect new funding for the high-performance computing program; planned growth in the ongoing high-speed research program, as well as the initiation of a new element of the high-speed research program in enabling propulsion materials; and the initiation of a program in advanced subsonic technology.

QUESTION 9:

What plans do you have for aeronautical hiring in the coming year, including fresh-out technical personnel? How many new graduates (S&T) were hired in 1990?

ANSWER 9:

In FY 1991, the OAET Centers (Ames, Langley and Lewis) have estimated that a total of 145 aeronautical hires will occur, 62 of which will be fresh-out technical personnel. In FY 1990, 61 scientist and technical graduates were hired in the aeronautical area.

QUESTION 10:

Please estimate the percentage of both the R&T Base and Systems Technology that is conducted "in-house."

ANSWER 10:

It is estimated that 70 percent of the Aeronautics R&T Base program and 55 percent of the Systems Technology programs will be conducted in house in FY 1992. The Numerical Aerodynamic Simulation activity is viewed as being an in-house effort although significant funding levels are associated with hardware purchases each year.

QUESTION 11:

Please provide an estimate of the R&PM request allocated to Aeronautical R&T and to Transatmospheric R&T.

ANSWER 11:

The NASA R&PM budget request for FY 1992 includes an estimated $386.3 million associated with the Aeronautics R&T program and $21.1 million associated with the Transatmospheric R&T program.

APPENDIX II

NASA AERONAUTICS & TRANSATMOSPHERIC PORTIONS OF NASA MULTIYEAR AUTHORIZATION ACT OF 1991

SUBCOMMITTEE MARKUP

WITH

SUBCOMMITTEE PRINT

MARKUP OF PENDING LEGISLATION

WEDNESDAY, APRIL 10, 1991

U.S. HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
SUBCOMMITTEE ON TECHNOLOGY AND COMPETITIVENESS,
Washington, D.C.

The subcommittee met, pursuant to notice, at 11:44 a.m. in room 2318, Rayburn House Office Building, Hon. Tim Valentine [chairman of the subcommittee] presiding.

Mr. VALENTINE. Today the Subcommittee on Technology and Competitiveness will mark up three bills: first, the aeronautics and transatmospheric portions of the subcommittee of the NASA Multiyear Authorization Act of 1991; secondly, the High Performance Computing Act of 1991; and finally, an updated version of subcommittee print of the American Technology Preeminence Act of 1991.

The importance of these first bills out of the subcommittee cannot be overemphasized. The first bill on the agenda, the subcommittee print of the NASA authorization, reflects the President's request for fiscal years 1992, 1993, and 1994 for the aeronautics and transatmospheric parts of the whole bill, and those sections in which our responsibilities have interest. The Space Subcommittee will mark up their parts of the print to complete the whole picture of the markup.

The aeronautics and transatmospheric parts of the NASA budget request fine tune ongoing advanced research programs. New initiatives in advanced subsonic technology are not fully funded. Aging aircraft studies and fly-by-light/power-by-wire are funded. Integrated wing design, terminal area productivity, and noise reduction are not authorized in this version. The terminal area productivity and noise reduction should be supported by FAA.

In supersonic and high speed research, the NASA requests are authorized, as is the rest of their request. The President's request for aeronautical R&D, in view of budget considerations, by and large appears on track.

I ask unanimous consent that we use a stripped subcommittee print, which is before the members, that contains only those portions of the bill of primary interest to this subcommittee, as original text for purposes of markup. Is there any objection?

[No response.]

Mr. VALENTINE. As I have stated, copies of the subcommittee print are before each member. At this point I would like to recognize those members who have opening statements, beginning, of course, with our distinguished ranking member, the gentleman from Florida, Mr. Lewis.

Mr. **Lewis**. Thank you, Mr. Chairman.

This markup of three very important pieces of legislation occurs just nine weeks after the Technology and Competitiveness Subcommittee was created. It is a tribute to your leadership, Mr. Chairman, to the support of the committee and subcommittee members, and to the professionalism of the great, super staff that we have. I congratulate you and the staff for this enormous effort.

During this nine weeks, almost all problems with the three bills before us have been resolved. The bipartisanship that has been established as a foundation for the subcommittee will go a long way toward seeing this legislation enacted into law.

The NASA aeronautics bill before us represents a strong commitment from the Administration. The research budget is up 15 percent over the fiscal year 1991 appropriating level, and the fiscal year 1993 and 1994 levels reflect increases of 13 percent and 7 percent respectively. These increases will ensure that the U.S. aeronautical technology advances are maintained.

As most of you know, the largest positive U.S. balance of trade in 1990 was aerospace, with a $25 billion positive balance. The long-term, high-risk programs of NASA aeronautics, including NASP, have made a major contribution to the U.S. leadership in aerospace technology. The NASP funding contained in the NASA authorization bill is at the level requested by the Administration.

The NASA legislation is a good bill and I urge members to support it.

The High Performance Computing bill has been extensively rewritten since the March 7th hearing to reflect the views of the witnesses, Administration, and members. I think it is important that the legislation pass the subcommittee so that a strong signal of support is sent.

High Performance Computing is a critical technology. The U.S. currently has the lead. This legislation is a step in the direction of ensuring that we maintain that lead.

The third bill, the American Technology Preeminence Act, has generated considerable interest among subcommittee members. We have tried to work in a bipartisan manner to include, where feasible, all member interests. This legislation is important because it addresses several technology and competitiveness issues. One such program is the aircraft fire research effort. This section mandates that NIST and FAA work jointly to improve fire-resistant aircraft cabin interiors. The effort combines the expertise of NIST with the FAA's need to produce results.

I urge all Technology and Competitiveness Subcommittee members to support all three of these bills, Mr. Chairman.

Thank you.

Mr. **Valentine**. Thank you very much.

Following the policy of recognizing members as of the time that they arrived at the subcommittee, and with apologies for any mistakes I might make, the Chair recognizes at this time the gentleman from Arkansas, Mr. Thornton.

Mr. **Thornton**. Thank you, Mr. Chairman. I have no preliminary statement. I am ready to proceed with the markup.

Mr. **Valentine**. Thank you, sir.

The Chair recognizes the lady from Maryland, Mrs. Morella.

Mrs. **Morella**. I agree. I am ready to move forward. I think these are excellent bills and I commend you, Mr. Chairman.

Mr. **Valentine**. I am encouraged by that.

Are there any members who have any opening statements to make?

[No response.]

Mr. **Valentine**. If not, we will proceed.

Please note, members of the subcommittee, that the three- year authorization applies to the research programs in this version. The 1993-1994 out years for research and program management—that is, salaries and administration—and cost of facilities are to be lumped and deferred to the Space Subcommittee and full committee.

Before each of you is a sub-agenda for the NASA bill markup, and I would now like to ask staff to briefly describe the pertinent elements of what we are about today on the NASA bill.

Mr. **Crossfield**. Thank you, Mr. Chairman.

In front of everybody is an agenda, the first page of which is little more than an index or table of contents. I would refer you to the next page, which tabulates the Aeronautical Research and Technology Base and the Systems Technology Program. Primary to that is that for fiscal year 1992, the chairman's recommendation is $591,200,000, which is extended—the authorization—the numbers are shown out to 1993 and 1994.

Research and Program Management is only for one year, being a pro rata part of a large sum that is in the whole NASA bill.

Facilities, $51,600,000, is really refurbishing of a badly deteriorated plant, and is also part of a larger facilities bill. We do not have, for our purposes here, authorization for 1993 and 1994.

On the next page is the Transatmospheric budget, which is the NASP, or the National Aerospace Plane budget, of $72 million for fiscal year 1992, which is the recommendation of the National Space Council when the problem with NASP was resolved two years ago up there.

The request from the President for $120 million in 1993 and $145 million in 1994 are increases over NASA's previous forecast, primarily because they are seeing a technical and a research job of larger magnitude than they originally initiated.

The next page just shows the trend of the expenditures of NASA Aeronautics R&D and the NASP Program over the last 10 years, and the cumulative trend, which doesn't really tell the story. On the following page you will see, in constant 1992 dollars, that the Aeronautics R&D funding has been essentially flat, if you also acknowledge the "no new start" dip of the early Reagan Administration era. The reason for that—it's quite acceptable—is that we haven't been in any new aeronautical arena for about 30 years now, so until the NASP returns are in, we won't have real reason for extensive and expensive new aeronautical research. This bill is just further refinement of what we've been doing for a number of years.

The next page is just a boilerplate, words and recommendations and description of the programs that will go with it. It gives us the breakdown for Program Management, which will pay the salaries for Aeronautical Research of 3,200 people, and on the Aerospace Plane, of 182 permanent people.

The list of approvals on page 7, which we will probably look at—I believe the chairman would like to look at it as one whole lump—what this does is include all of those things that are in the bill that you are being asked to approve in this markup today. I could go through them, but it would just be a recitation of more numbers and things of that nature.

So the recommendation—if you accept these seven approval items, would be like accepting the committee print of this bill, and it simply approves what is in the print.

So in addition to that, then, we will have adoption of language for the report, and that's pretty much straightforward. That would be on pages 9, 10, 11, and 12. And for the Transatmospheric Research and Technology, 12 and 13. The only thing that really would be new here, but isn't any surprise, is that the committee has found that the NASA maintenance is quite deficient in keeping their plant up to the manner that the committee would like to see it, or really, that NASA should do it, and so there are some extensive words in the report that will recommend to NASA that they appoint a "head mother" at headquarters level to run their maintenance operation to see if they could bring that back up to speed.

With that, I believe that that pretty much summarizes what the bill is, and I believe that Mr. Lewis may have some additional recommendations.

Mr. VALENTINE. Thank you, Mr. Crossfield.

Mr. Lewis?

Mr. LEWIS. The only recommendation, Mr. Chairman, that I would have would be in report language, a motion by the ranking member of the full committee, Mr. Walker, with reference to positive technology.

Mr. Rohrabacher, do you have an amendment that you are going to offer today?

Mr. ROHRABACHER. Yes, I do.

Mr. VALENTINE. Is this an amendment? Okay. I guess it's appropriate. Go ahead and proceed with that.

Mr. ROHRABACHER. This is report language, Mr. Chairman.

The National Aerospace Plane Program underwent a major change this year, with the Department of Defense and NASA testifying in favor of the project for the first time. The reason for this sudden religious conversion, especially on the part of the Department of Defense, is that many of us, including yourself, Mr. Chairman, Mr. Lewis, Mr. Walker, Mr. McCurdy, and others, such as Mr. Murtha, have kept the pressure on the Department of Defense for this vital program. One of the ways that we all have tried to keep this pressure on is through the use of committee report language.

The report language from our bill last year is still mostly appropriate to the situation that we find ourselves in this year; but nevertheless, it could be updated and strengthened.

Mr. Chairman, what I would like to do and what I would like to propose is that last year's report language on the National Aerospace Plane be used as report language on the National Aerospace Program this year after it has been punched up and after it has been strengthened. I understand our staff is working right now on language that will strengthen this commitment.

I believe that if we do that, it will serve to keep the pressure both on the Department of Defense and on NASA to make sure that this program isn't undercut.

So what I would ask is that the subcommittee staff draft this language—in other words, strengthen the language— similar to the language in Report 101-763, and circulate it to the members of this committee for comment before including it in the Technology and Competitiveness report.

Mr. VALENTINE. Do all of the members of the subcommittee understand the gentleman's proposition? Let me attempt to restate it.

As I understand it, there are certain expressions that the gentleman from California would like to include in report language. Not having that in the desired form, he would like to submit language to members of the committee for general approval.

If members have any objection to that, this can be dealt with when the bill comes before the full committee.

Mr. ROHRABACHER. Yes, sir.

Mr. VALENTINE. I don't see any problem. Does any member have any objection to that or have any statements about it? We don't want to, certainly, do anything to foreclose a free exchange of ideas, but I would hesitate to suggest to the subcommittee that we approve anything that we haven't seen. So I think with that understanding, if everybody agrees to that, then we will, without objection, proceed in that manner.

Let me ask, then, if there are any other statements with respect to report language, or if there is any discussion, or if there are any questions of Mr. Crossfield, since he is the man with all the answers.

Mr. Lewis?

Mr. LEWIS. Mr. Chairman, I have one amendment for report language that I am offering for Mr. Walker, the ranking member of the committee, in reference to Composite Technology Programs as well as Advanced Aluminum Development for both widebody transport and high-speed commercial transport.

Mr. VALENTINE. May I ask the gentleman, that proposed report language is in the package and is before the members of the committee?

Mr. LEWIS. Yes.

Mr. VALENTINE. We have no objection to that. Does any member have any comment or any statement? Is there any objection?

[No response.]

Mr. VALENTINE. If not, we will include that language which, for the benefit of members, was included when this measure was considered last Congress.

Are there any amendments?

[No response.]

Mr. VALENTINE. The Chair will entertain a motion to report the bill to the full committee.

Mr. LEWIS. Mr. Chairman, do we have to make a motion to approve the seven—that's taken care of? Okay.

Mr. Chairman, I move the subcommittee report the bill as amended. Furthermore, I move to instruct the staff to prepare the subcommittee report, to make technical and conforming amendments, and that the chairman take all necessary steps to bring the bill, NASA Aeronautics Authorization for Fiscal Year 1992, before the full committee for consideration.

Mr. **Valentine**. You have heard the motion. All in favor of the motion, let it be known by saying aye.

[Chorus of ayes.]

Mr. **Valentine**. Those opposed, nay.

[No response.]

Mr. **Valentine**. The motion carries.

The Chair will now entertain a motion to approve the recommended report language for inclusion in the subcommittee report to the full committee, subject to the provision and with the understanding that we have had with respect to the language which will be tendered by the gentleman from California, Mr. Rohrabacher.

Mr. **Lewis**. Mr. Chairman, I move that the proposed committee views be adopted by the subcommittee.

Mr. **Valentine**. You have heard the motion. All in favor of the motion, let it be known by saying aye.

[Chorus of ayes.]

Mr. **Valentine**. Those opposed, nay.

[No response.]

Mr. **Valentine**. The ayes have it and that bill is approved.

[Note: See the Fiscal Year 1992 NASA Authorization Committee Print of the Subcommittee on Space of the Committee on Science, Space, and Technology for the full committee markup proceedings on this legislation.]

SUBCOMMITTEE ON TECHNOLOGY AND COMPETITIVENESS

Markup Agenda -- March 21, 1991
9:30am; Room 2318 Rayburn

Subcommittee Print, NASA Authorization
(aeronautical/transatmospheric programs)

Opening Remarks -- Chairman Valentine

1. Staff briefing on approval of Subcommittee Print, the National Aeronautics and Space Administration Multiyear Authorization Act of 1991 (Aeronautical and Transatmospheric programs)

Discussion of the 7 motions for approval [p.7-8]

1. General bill language approval
2.,3. Three year R&T authorizations
4. One year facilities authorizations
5. Findings, Aeronautics Research & NASP
6. Centralized Maintenance and repair directive
7. Research and Program Management, Aero & NASP

Brief of recommended language to accompany the bill

Chairman: asks for motions of approval:

Motion #1
Motion #2
Motion #3
Motion #4
Motion #5
Motion #6
Motion #7

OR One motion to approve 1 through 7

Motion to adopt report language [p.9-16]

Motion to Report the Bill [p.16]

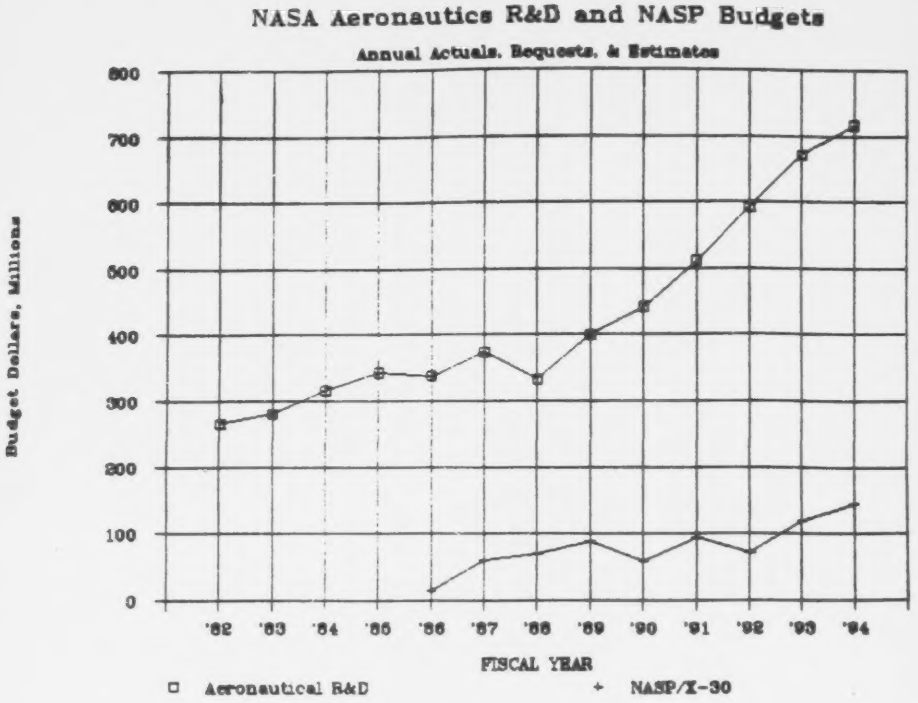
Reference:
-- Aeronautics: Sec. 2(1); Sec. 3(a)(1)(A), [p.2]
-- Transatmospheric: Sec. 2(2); Sec. 3(a)(1)(B), [p.3]
-- Facilities: Sec. 3(a)(2)(A) through (F), [p.3]
-- Research and Program Management: Sec. 3(a)(3), [p.3]

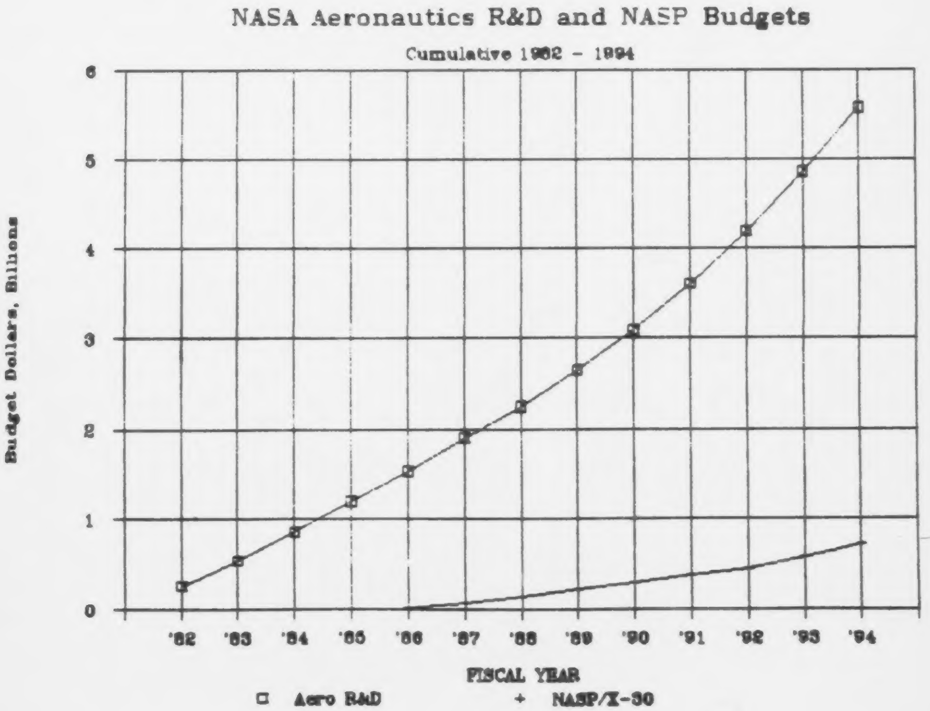
Review of Aeronautical and Transatmospheric Programs of FY 92-94 NASA Authorization

(thousands of dollars)

		1990 Actual	1991 Original Estimate	1991 Current Estimate	1992 Budget Estimate	Chairman's Recommendations 1992	Chairman's Recommendations 1993	Chairman's Recommendations 1994
	AERONAUTICAL							
	RESEARCH AND TECHNOLOGY BASE							
1.	Research and Technology							
	Aerodynamics R&T	104,400	120,400	116,500	128,300	128,300	142,500	144,100
	Propulsion and Power R&T	67,900	75,700	71,700	84,100	84,100	88,300	92,000
	Materials and Structures R&T . .	40,100	41,400	37,200	42,800	42,800	45,400	47,200
	Controls, Guidancem and Human Factors R&T	63,200	65,000	60,300	67,600	67,600	71,500	74,400
	Flight Systems R&T	38,300	40,600	40.400	42,100	42,100	44,600	46,300
	Systems Ana;ysis	7,900	10,300	10,300	10,700	10,700	11,200	11,700
1A	Total	321,800	353,400	336,400	375,600	375,600	403,500	415,700
	SYSTEMS TECHNOLOGY PROGRAMS							
	High perfomance Computing . . .	Ref 2,000		17,000	17,000	17,000	49,000	73,000
	Materials and Structures Systems Technology	28,100	39,900	39,900	40,100	40,100	35,500	36,300
	Rotorcraft Systems Tech	3,600	5,100	5,100	5,200	5,200	5,400	5,500
	High Performabce Aircraft Systems Tech . . .	9,700	10,500	10,500	11,100	11,100	11,900	12,200
	Advanced Propulsion Systems Tech	13,100	15,000	15,000	15,400	15,400	16,000	16,400
	Numerical Aerodynamic Simulation	41,800	44,100	44,100	45,400	45,400	47,000	48,100
	High Speed Research	24,500	44,000	44,000	76,400	76,400	89,900	90,400
	Advanced Subsonic Tech				5,000	5,000	12,300	18,400
1b	Total	120,800	158,600	175,600	215,600	215,600	267,000	300,300
1c	TOTAL	442,600	512,000	512,000	591,200	591,200	670,500	716,000
2.	Research & Program Mgt., Aeronautics portion (p._)	333,400	367,000	360,600	386,300	386,300		
3.	Construction of Facilities, Aeronautical Facilities (p._)	61,200	56,000	46,000	51,600	51,600		
	TOTAL	837,200	935,000	918,600	1,029,100	1,029,100		

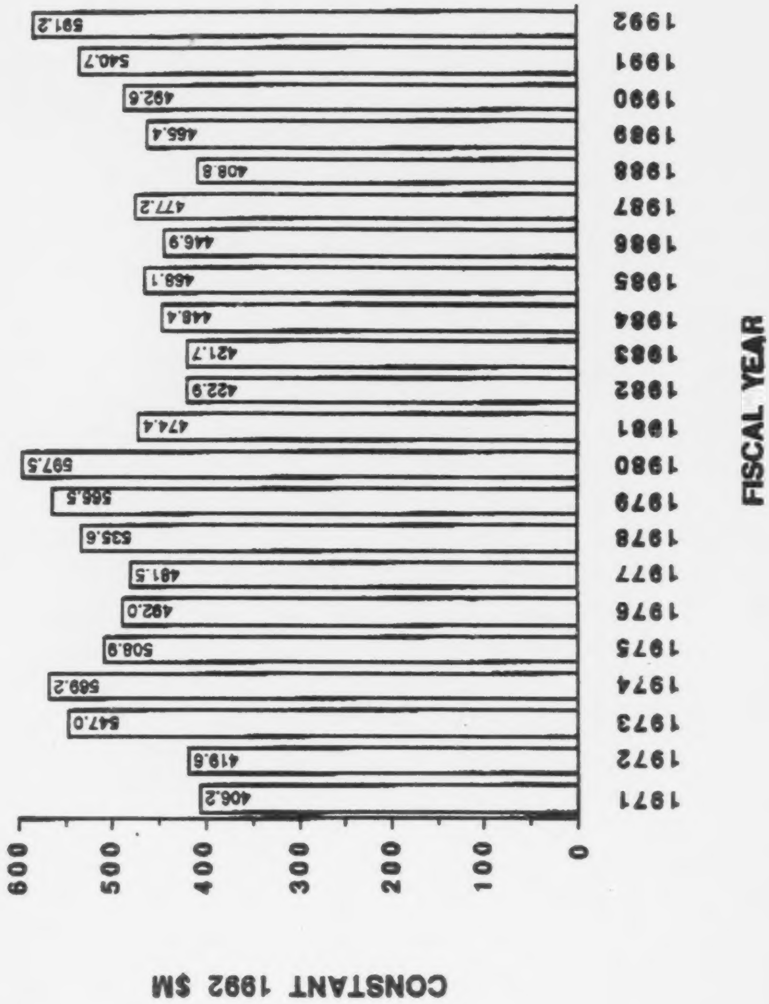
	1990	1991		1992	Chairman's Recommendations		
	Actual	Original Estimate	Current Estimate	Budget Estimate	1992	1993	1994
TRANSATMOSPHERIC							
1. Research and Technology	59,000	127,000	95,000	72,000	72,000	120,000	145,000
2. Research & Program Mgm ..... Transatmospheric portion	18,400	21,800	21,000	21,000	21,000		
TOTAL	77,400	148,800	116,000	93,000	93,000		


NASA Aeronautics R&D and NASP Budgets
Annual Actuals, Requests, & Estimates
Budget Dollars, Millions
800
700
600
500
400
300
200
100
0
'82
'83
'84
'85
'86
'87
'88
'89
'90
'91
'92
'93
'94
FISCAL YEAR
□ Aeronautical R&D
+ NASP/X-30


NASA Aeronautics R&D and NASP Budgets
Cumulative 1982 - 1994
Budget Dollars, Billions
6
5
4
3
2
1
0
'82
'83
'84
'85
'86
'87
'88
'89
'90
'91
'92
'93
'94
FISCAL YEAR
□ Aero R&D
+ NASP/X-30

AERONAUTICS R&D FUNDING TREND

OAET



Aeronautics

Research and Program Management Breakdown:

Of the total NASA request for Research and Program Management for FY 92 ($3.452 billion) $386.3 is requested to cover the civil service staff needed to perform in-house aeronautical research and management activities, other elements of operational costs such as travel, operation of facilities, janitorial and administrative support.

This amount provides for 3,275 permanent civil service employees.

Construction of Facilities Breakdown

The Construction of Facilities budget request for FY '92 includes funds for follow on of a comprehensive plan for rehabilitation upgrade, modernization and repair of many of NASA's major wind tunnels and research facilities $51.6M

TRANSATMOSPHERIC

Research and Program Management Breakdown

The request contains $21.05 million to cover 182 permanent civil service employees.

ADOPTION OF AMENDMENTS TO THE COMMITTEE PRINT

Chairman's recommendation: Motions for:

1. **Approval of:**
    Section 1. Short Title, p. 2.
    Section 4. Construction of Facilities Reprogramming, p. 6-7.
    Section 5. Special Reprogramming Authority for Construction of Facilities, p. 7-8.
    Section 6. Consideration by Committees, p. 8-9.
    Section 7. SBIR Program, p. 9.

2. **Approval of:**Sec. 3(a)(1)(A) on page 2, lines 22 - 24 and page 3, line 1: --- 591,200,000 for fiscal year 1992; 670,500,000 for fiscal year 1993; and 716,000,000 for fiscal year 1994.

3. **Approval of:**Sec. 3(a)(1)(B) on page 3, lines 2 - 5: --- 72,000,000 for fiscal year 1992; 120,000,000 for fiscal year 1993; 145,000,000 for fiscal year 1994.

4. **Approval of:**Sec. 3(a)(2)(A) through (F) on page 3, lines 6 - 20: (A) Repair and modification of the 12-foot Pressure Wind Tunnel, Ames Research Center, $25,000,000.
    (B) Upgrade of Out door Aerodynamic Research Facility, Ames Research Center, $3,300,000.
    (C) Modernization of 16-foot Transonic Tunnel, Langley Research Center, $3,400,000.
    (D) Modifications to the High Pressure Air System, Langley Research Center, $11,700,000.
    (E) Rehabilitation of Central Air System, Lewis Research Center, $5,600,000.
    (F) Rehabilitation of Icing Research Tunnel, Lewis Research Center, $2,600,000.

5. **Approval of:**Sec. 2(1) and (2):
    - on page 2, lines 5 - 9: (1) the aeronautical program contributes to the Nation's technological competitive advantage, and it has been a key factor in maintaining preeminence in aviation over many decades; and
    - on page 2, lines 10 -15: (2) the National Aero-Space Plane program can have benefits to military and civil aviation programs from the new and innovative technologies developed in propulsion systems, aerodynamics, and control systems that could be enormous, especially for high speed aeronautics and space flight.

6. **Approval** of:Sec. 8, p. 9, lines 15 -19: Office of Facilities Maintenance. The Administrator shall create an Office of Facilities Maintenance, which shall have complete authority to plan and direct facilities maintenance management for all National Aeronautics and Space Administration sites.

7. **Approval** of:Sec. 3(a)(3) p. 3, lines 21 - 22: Aeronautical and Transatmospheric Research and Program Management prorata allocation.

ADOPTION OF LANGUAGE FOR THE REPORT

to accompany the bill

AERONAUTICAL RESEARCH AND TECHNOLOGY

COMMITTEE PRINT, SEC. 3(a)(1)(A)

President's request for fiscal year 1992 and estimates for subsequent years:

Fiscal Year	
1992	$591,200,000
1993	$670,500,000
1994	$716,000,000

Fiscal Year 1991 NASA Authorization, H.R. 4196

Fiscal Year:	
1992	$634,500,000
1993	$665,000,000

Committee recommendation for additional authorization:

Fiscal Year:	
1992	($43,300,000)
1993	$5,500,000
1994	$716,000,000

Committees authorization recommendation:

SEC. 3(a)(1)(A) authorizes the amount of the request for fiscal years 1992, 1993, and 1994 for the Aeronautical appropriations.

Program description

The goal of the NASA Aeronautical program is to conduct research and develop technology to strengthen U.S. leadership in civil and military aviation. This goal is supported by five comprehensive program objectives: (1) emphasize emerging technologies with potential for order-of-magnitude advances in capacity or performance which will enhance the U.S. defense and economic competitiveness; (2) maintain NASA's laboratory strength by repairing and modernizing critical aging national facilities, providing advance scientific computational capabilities and enhancing staff technical excellence; (3) ensure the timely transfer of research results to the U.S. aeronautics community through reports, conferences, workshops, and active participation of industry in cooperative research programs; (4) ensure the strong involvement of universities in NASA's program to broaden the nation's base of technical expertise; and (5) facility support to the Department of Defense (DOD), other government agencies, and the U.S. industry for major aeronautical programs.

Committee View

The Committee has recommended in the past that NASA increase its cooperative efforts with FAA and is pleased to see this as a major effort in the FY 1992 budget proposal. The areas chosen for emphasis between NASA and FAA include severe weather, human factors and air worthiness, among other things. The Committee strongly supports this effort and urges NASA to increase long-term research efforts in aging aircraft research, nondestructive evaluation, fire safety and other areas that will prevent aviation accidents from occurring.

TRANSATMOSPHERIC RESEARCH AND TECHNOLOGY

SEC. 3(a)(1)(B)

President's request for fiscal year 1992 and estimates for subsequent years:

Fiscal Year:	
1992	$72,000,000
1993	$120,000,000
1994	$145,000,000

Fiscal year 1991 NASA Authorization, H.R. 4196

Fiscal Year:	
1992	$72,000,000
1993	$68,000,000

Committee recommendation for additional authorization:

Fiscal Year:	
1992	$0
1993	$42,000,000
1994	$145,000,000

Committee authorization recommendation

SEC. 3(a)(1)(B) authorizes no additional appropriations for fiscal year 1992 for Transatmospheric Research and Technology. The fiscal year 1992 Presidents request for fiscal years 1993 and 1994 authorization is increased $42,000,000 and $145,000,000 over the authorization of 1990. The Committee recommends authorization at the FY 1992 request levels.

Program description

The transatmospheric research and technology program is a portion of the joint NASA/Department of Defense (DOD) National Aero-Space Plane (NASP) program. The program objective is to develop and then demonstrate, in experimental flight vehicles, the technology required to permit the Nation to develop reusable, single-stage-to-orbit (SSTO) vehicles with airbreathing primary propulsion and horizontal takeoff and landing.

Committee View

The Committee finds that the Administration's expression of strong support for NASP is very welcome. Moreover, the OSTP, DOD, NASA, and the USAF testimony that the program is a top priority, has both civil and military applications, and should be funded through Phase 3, should assure Congress that it will move forward as scheduled. The Committee also expresses continued strong support for the NASP research program.

Facility Maintenance

The Committee has had a long standing interest in the maintenance of NASA's facilities. For example, the Committee vigorously supported NASA's Wind Tunnel Revitalization Program. The Committee often has expressed a need for NASA to properly maintain its facilities in order to meet program objectives. Moreover, when performed on a timely basis, a first class maintenance program can reduce the need for major repairs at a later date.

The Committee congratulates NASA for being forthright and sincere in its testimony before the Committee on March 5, 1991 when Samuel W. Keller, Associate Deputy Administrator, testified for NASA that:

> "I certainly would agree that Admiral Truly's comments that the state of our maintenance at the present time is the result of a large number of independent decisions that have been made over the years." Hearing before the U.S. House of Representatives, Committee on Science, Space, and Technology, March 5, 1991, Transcript at page 63 - 64.

The Committee is disappointed, however, with NASA's defense of its present facilities maintenance management structure since that day. There has been no indication from NASA, that it intends to correct the basic problem of elevating the importance of facility maintenance within its management structure.

The Committee strongly believes that the authority and responsibility for facility maintenance should be centralized. Centralizing the authority and responsibility for facility maintenance should improve the condition of NASA's facilities in a short period of time and should be less costly than is currently the case.

The Committee finds NASA's maintenance responsibilities are fragmented throughout five organizations at the Headquarters level: Research and Program Management, three major Program Offices, and Construction of Facilities. However, while NASA's Budget Summaries specify funding for maintenance under Research and Program Management and Construction of Facilities, the Budget Summaries do not specify funding for facility maintenance under the Research and Development Programs.

Furthermore, while there is a Director Of Institutions in at east one of the Program Offices, and while there is a competent irector for Facilities within that organization, the degree of uthority of that Director is unclear since the authority for xpending funds seems to by-pass that person and go directly through to the Center Director. The December 1990 General Accounting Office's "Report to the Chair, Subcommittee on VA, HUD and Independent Agencies, Committee on Appropriations, U.S. Senate on NASA Maintenance: Stronger Commitment Needed to Curb Facility Deterioration" contained the following statement on page 21:

> "NASA Headquarters has not provided comprehensive guidance to standardize the operation of the centers' maintenance management systems. Consequently, there is no standard maintenance system within NASA, and each center has developed its own approach to plan, budget, schedule, and report on maintenance requirements."

For example, in two of the NASA centers, there are three separate organizations all related to facilities. The Committee is of the opinion that organizational boundaries frequently lead to low morale and poor performance. Finally, at the Centers, institutional facility maintenance is included with security services, janitorial services and expenditures for utilities.

In the opinion of the Committee, the age of NASA's facilities require somewhat higher investments in maintenance than has been made in the past. However, the Committee cannot, in good conscience, recommend any increase unless and until NASA establishes one single office at the Headquarters level accountable for and with the authority to develop and direct an effective facility maintenance program throughout NASA. The Committee looks forward to the appointment of a qualified individual to direct this program early in FY 1992.

MOTION TO REPORT THE BILL

Move:

That the Subcommittee Chairman report to the Full Committee the Subcommittee actions on the National Aeronautics and Space Administration Multiyear Authorization Act of 1991, as amended, along with language agreed to, and direct the staff to prepare such materials as may be necessary to reflect the actions taken.

BROWCA033

HLC

The National and Aeronautics and Space Administration Multiyear Authorization Act of 1991, as Reported by the Subcommittee on Technology and Competitiveness, April 10, 1991

102D CONGRESS
1ST SESSION

H. R. ___

IN THE HOUSE OF REPRESENTATIVES

Mr. BROWN (for himself and Mr. WALKER) introduced the following bill; which was referred to the Committee on ______________

A BILL

To authorize appropriations to the National Aeronautics and Space Administration for research and development, construction of facilities, and research and program management, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the ``National Aeronautics and Space Administration Multiyear Authorization Act of 1991.''.

SEC. 2. FINDINGS.

Congress finds that--

(1) the aeronautical program contributes to the Nation's technological competitive advantage, and it has been a key factor in maintaining preeminence in aviation over many decades; and

(2) the National Aero Space Plane program can have benefits to the military and civilian aviation programs from the new and innovative technolgies developed in propulsion systems, aerodynamics, and control systems that could be enormous, especially for high-speed aeronautical and space flight.

SEC. 3. AUTHORIZATION OF APPROPRIATIONS.

(a) AUTHORIZATIONS.--There are authorized to be appropriated to the National Aeronautics and Space Administration the following amounts:

(1) For ``research and development'', for the following programs:

(A) Aeronautical research and technology, $591,200,000 for fiscal year 1992, $670,500,000 for fiscal year 1993, and $716,000,000 for fiscal year

1994.

(B) Transatmospheric research and technology, $72,000,000 for fiscal year 1992, $120,000,000 for fiscal year 1993, and $145,000,000 for fiscal year 1994.

(2) For ``construction of facilities'', including land acquisition, for fiscal year 1992 as follows:

(A) Repair and modernization of the 12-foot Pressure Wind Tunnel, Ames Research Center, $25,000,000.

(B) Upgrade of Outdoor Aerodynamic Research Facility, Ames Research Center, $3,300,000.

(C) Modernization of 16-foot Transonic Tunnel, Langley Research Center $3,400,000.

(D) Modifications to the High Pressure Air System, Langley Research Center, $11,700,000.

(E) Rehabilitation of Central Air System, Lewis Research Center, $5,600,000.

(F) Rehabilitation of Icing Research Tunnel, Lewis Research Center, $2,600,000.

(3) For ``research and program management'', $2,452,300,000 for fiscal year 1992.

(b) LIMITATIONS.--(1)(A) Notwithstanding paragraph (4), appropriations authorized under this section for ``research and development'' may be used--

(i) for any items of a capital nature (other than acquisition of land) which may be required at locations other than installations of the National Aeronautics and Space Administration for the performance of research and development contracts; and

(ii) for grants to nonprofit institutions of higher education, or to nonprofit organizations whose primary purpose is the conducting of scientific research, for purchase or construction of additional research facilities.

Title to facilities described in clause (ii) shall be vested in the United States unless the Administrator determines that the national program of aeronautical and space activities will best be served by vesting title in any such grantee institution or organization. Each such grant shall be made under such conditions as the Administrator shall determine to be required to ensure that the United States will receive therefrom benefit adequate to justify the making of that grant.

(B) None of the appropriations authorized under this section for ``research and development'' may be used in accordance with this paragraph for the construction of any facility, the estimated cost of which, including collateral equipment, exceeds $750,000, unless the Administrator has notified the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate of the nature, location, and estimated cost of such facility.

(2) Appropriations authorized under this section for ``research and development'' or for ``construction of facilities'' may remain available until expended. Appropriations authorized under this section for ``research and program management'' for maintenance and operation of facilities, and for other services, shall remain available through the next fiscal year after the fiscal year for which such amount is appropriated.

(3) Not to exceed $35,000 of appropriations authorized under this section for ``research and program management'' may be used for scientific consultations or extraordinary expenses upon the approval or authority of the Administrator, and the Administrator's determination shall be final and conclusive upon the accounting officers of the Government.

(4)(A) Except as provided in paragraph (1)(A), appropriations authorized under this section for ``research and development'' or ``research and program management'' may be used for the construction of new facilities and additions to, or repair, rehabilitation, or modification of existing facilities, but only if the cost of each such project, including collateral equipment, does not exceed $200,000.

(B) Except as provided in paragraph (1)(A), appropriations authorized under this section for ``research and development'' may be used for unforeseen programmatic facility project needs, but only if the cost of each such project need, including collateral equipment, does not exceed $750,000.

(C) Appropriations authorized under this section for ``research and program management'' may be used for repair, rehabilitation, or modification of existing facilities controlled by the General Services Administration, but only if the cost of each such project, including collateral equipment, does not exceed $500,000.

SEC. 4. CONSTRUCTION OF FACILITIES REPROGRAMMING.

Appropriations authorized under section 3(a)(2)(A) through (F)--

(1) may be varied upward 10 percent, in the discretion of the Administrator or the Administrator's designee; or

(2) following a report by the Administrator or the Administrator's designee to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate on the particular circumstances, may be varied upward 25 percent to meet unusual cost variations.

The total amount of appropriations authorized under section 3(a)(2)(A) through (F) shall not be increased as a result of actions taken under paragraphs (1) and (2) of this section.

SEC. 5. SPECIAL REPROGRAMMING AUTHORITY FOR CONSTRUCTION OF FACILITIES.

Where the Administrator determines that new developments or scientific or engineering changes in the national program of aeronautical and space activities have occurred; and that such changes require the use of additional funds for the purposes of construction, expansion, or modification of facilities at any location; and that deferral of such action until the enactment of the next authorization Act would be inconsistent with the interest of the Nation in aeronautical and space activities; the Administrator may transfer not to exceed one-half of 1 percent of the funds appropriated pursuant to section 3(a)(1) to the ``construction of facilities'' appropriation for such purposes. The Administrator may also use up to $10,000,000 of the amounts authorized under section 3(a)(2) for such purposes. The funds so made available pursuant to this section may be expended to acquire, construct, convert, rehabilitate, or install permanent or temporary public works, including land acquisition, site preparation, appurtenances, utilities, and equipment. No such funds may be obligated until a period of 30 days has passed after the Administrator or the Administrator's designee has transmitted to the Committee on Science, Space, and Technology of the House of

Representatives and the Committee on Commerce, Science, and Transportation of the Senate a written report describing the nature of the construction, its cost, and the reasons therefor.

SEC. 6. CONSIDERATION BY COMMITTEES.

Notwithstanding any other provision of this Act--

(1) no amount appropriated pursuant to this Act may be used for any program deleted by the Congress from requests of the Administrator as originally made to either the Committee on Science, Space, and Technology of the House of Representatives or the Committee on Commerce, Science, and Transportation of the Senate;

(2) no amount appropriated pursuant to this Act may be used for any program in excess of the amount actually authorized for that particular program by section 3(a)(1) and (3); and

(3) no amount appropriated pursuant to this Act may be used for any program which has not been presented by the Administrator to either such committee,

unless a period of 30 days has passed after the receipt by each such committee of notice given by the Administrator containing a full and complete statement of the action proposed to be taken and the facts and circumstances relied upon in support of such proposed action. The National Aeronautics and Space Administration shall keep the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate fully and currently informed with respect to all activities and responsibilities within the jurisdiction of those committees. Any Federal department, agency, or independent establishment shall furnish any information requested by either committee relating to any such activity or responsibility.

SEC. 7. SMALL BUSINESS INNOVATION RESEARCH PROGRAM.

The Administrator may utilize up to 5 percent of the funds provided for the Small Business Innovation Research Program pursuant to section 4(f) of the Small Business Innovation Development Act of 1982, for program management and promotional activities.

SEC. 8. OFFICE OF FACILITIES MAINTENANCE.

The Administrator shall create an Office of Facilities Maintenance, which shall have complete authority to plan and direct facilities maintenance management for all National Aeronautics and Space Administration sites.

APPENDIX III

REPORT BY THE CHAIRMAN
SUBCOMMITTEE ON TECHNOLOGY AND COMPETITIVENESS
TO THE
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
ON THE
NASA MULTIYEAR AUTHORIZATION ACT OF 1991
(Aeronautical & Transatmospheric Portions)

DRAFT ------------------------------ DRAFT

MEMORANDUM

To: *George E. Brown, Jr., Chairman*
Committee on Science, Space, and Technology

From: *Tim Valentine, Chairman*
Subcommittee on Technology and Competitiveness

Re: *Subcommittee Report on the NASA Multiyear Authorization Act of 1991 (aeronautical/transatmospheric portions)*

Attached is the report by the Subcommittee on Technology and Competitiveness on the NASA Multiyear Authorization Act of 1991 (Subcommittee Print of aeronautical and transatmospheric portions as amended). The Subcommittee's portions of the act, as amended, were ordered reported to the Full Committee by unanimous voice vote on April 10, 1991. Subcommittee views and language that were adopted to accompany the legislative report are included.

April 10, 1991

REPORT BY THE CHAIRMAN

SUBCOMMITTEE ON TECHNOLOGY AND COMPETITIVENESS

to the

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

on the

NASA MULTIYEAR AUTHORIZATION ACT OF 1991

(Subcommittee print of pertinent sections)
(aeronautical/transatmospheric portions)

A. OVERALL SUMMARY

1. *The Subcommittee on Technology and Competitiveness has acted on its part of the NASA Multiyear Authorization Act of 1991, reporting the Subcommittee Print, as amended, to the Full Committee by unanimous voice vote.*
2. *That part of the FY 92-94 request for new budget authority that is under the jurisdiction of this Subcommittee is shown below:*

	1990	*1991* *Budget Estimate*	*Current Plan*	*1992*	*1993*	*1994*
		(millions of dollars)				
Aeronautical Research and Technology.......	*442.6*	*512.0*	*512.0*	*591.2*	*670.5*	*716.0*
Transatmospheric Research & Technology..	*59.0*	*127.0*	*95.0*	*72.0*	*120.0*	*145.0*
Construction of Facilities...........	*61.2*	*56.0*	*46.0*	*51.6*	-	-
Research & Program Management..........*	*351.8*	*388.8*	*381.6*	*407.3*	-	-
TOTAL	***914.6***	***1083.8***	***1034.6***	***1122.1***	-	-

**Includes funding allocatable to Aeronautical & Transatmospheric R&T*

3. *The Subcommittee, working with the Subcommittee Print adopted the Subcommittee Print reflecting the President's request and the Subcommittee's findings.*

B. REPORT LANGUAGE

The Subcommittee adopted the following language for the report to accompany the bill.

AERONAUTICAL RESEARCH AND TECHNOLOGY

SEC. 3(a)(1)(A)

President's request for fiscal year 1992 and estimates for subsequent years:

Fiscal	Year
1992	$591,200,000
1993	$670,500,000
1994	$716,000,000

Fiscal year 1991 NASA Authorization, H.R. 4196:

Fiscal	Year
1992	$634,500,000
1993	$665,000,000

Committee recommendation for additional authorization:

Fiscal	Year
1992	($43,300,000)
1993	$5,500,000
1994	$716,000,000

Committee's authorization recommendation:

SEC. 3(a)(1)(A) authorizes the amount of the request for fiscal years 1992, 1993, and 1994 for the Aeronautical Research appropriations.

Program description

The goal of the NASA Aeronautical program is to conduct research and develop technology to strengthen U.S. leadership in civil and military aviation. This goal is supported by five comprehensive program objectives: (1) emphasize emerging technologies with potential for order-of-magnitude advances in capacity or performance which will enhance the U.S. defense and economic competitiveness; (2) maintain NASA's laboratory strength by repairing and modernizing critical aging national facilities, providing advance scientific computational capabilities and enhancing staff technical excellence; (3) ensure the timely transfer of research results to the U.S. aeronautics community through reports, conferences, workshops, and active participation of industry in cooperative research programs; (4) ensure the strong involvement of universities in NASA's program to broaden the nation's base of technical expertise; and (5) facility support to the Department of Defense (DOD), other government agencies, and the U.S. industry for major aeronautical programs.

Committee View

The Committee has recommended in the past that NASA increase its cooperative efforts with FAA and is pleased to see this as a major effort in the FY 1992 budget proposal. The areas chosen for emphasis between NASA and FAA include severe weather, human factors and air worthiness, among other things. The Committee strongly supports this effort and urges NASA to increase long-term research efforts in aging aircraft research, nondestructive evaluation, fire safety and other areas that will prevent aviation accidents from occurring.

The advanced Composite Technology program continues to provide support for polymer matrix composite development and cost reduction based on performance projections that continue to be unrealistic in relation to accomplishments. A balanced program is needed between polymer matrix composites and monolithic aluminum alloys in order to assure that backup materials are available if the polymer goals are not reached. Funding for advanced aluminum development for both wide-body transports and the High Speed Commercial Transport, therefore, needs to be emphasized. Structural material research for HSCT must be accelerated in order to meet the time frame for materials selections in 1995 to support certification early in the first decade of the next century.

TRANSATMOSPHERIC RESEARCH AND TECHNOLOGY

SEC. 3(a)(1)(B)

President's request for fiscal year 1992 and estimates for subsequent years:

Fiscal Year:	
1992	$72,000,000
1993	$120,000,000
1994	$145,000,000

Fiscal year 1991 NASA Authorization, H.R. 4196

Fiscal Year:	
1992	$72,000,000
1993	$68,000,000

Committee recommendation for additional authorization:

Fiscal Year:	
1992	$0
1993	$42,000,000
1994	$145,000,000

Committee authorization recommendation

SEC. 3(a)(1)(B) authorizes no additional appropriations for fiscal year 1992 for Transatmospheric Research and Technology. The fiscal year 1992 Presidents request for fiscal years 1993 and 1994 authorization is increased $42,000,000 and $145,000,000 over the authorization of 1990. The Committee recommends authorization at the FY 1992 request levels.

Program description

The transatmospheric research and technology program is a portion of the joint NASA/Department of Defense (DOD) National Aero-Space Plane (NASP) program. The program objective is to develop and then demonstrate, in experimental flight vehicles, the technology required to permit the Nation to develop reusable, single-stage-to-orbit (SSTO) vehicles with airbreathing primary propulsion and horizontal takeoff and landing.

Committee Views

The Committee finds that the Administration's expression of strong support for NASP is very welcome. Moreover, the OSTP, DOD, NASA, and the USAF testimony that the program is a top priority, has both civil and military applications, and should be funded through Phase 3, should assure Congress that it will move forward as scheduled. The Committee also expresses continued strong support for the NASP research program.

National Aero-Space Plane Program

The National Aero-Space Plane (NASP) program was originally established by President Reagan as a high national priority in the January 1986 State of the Union address. A joint program was immediately established between the Department of Defense (DOD) and the National Aeronautics and Space Administration (NASA) in July 1986.

The Program is divided into three phases. Phase 1 was the concept feasibility study (called Copper Canyon) which ran from 1982 to 1985 and was essentially a pre-NASP phase. The study results defined the technical concept for the NASP program to be developed on Phases 2 and 3. Both phases have been revised since the first joint agreement.

The goal of Phase 2, the Concept Validation program, is to prove the relevant technologies are sufficiently mature to support the development of an experimental vehicle, the X-30. At the completion of Phase 2 in 1993, the progress in technology development will be assessed to determine if it is feasible to continue to Phase 3 in which two prototype vehicles would be manufactured and flown with the first flight in 1997. This schedule calls for a single-stage-to-orbit in 1999. These X-30 vehicles will be experimental vehicles with no operational missions or requirements.

The technologies that must be developed for the X-30 to fly include:

(a) a propulsion system designed primarily as an air-breathing multi-cycle ram/scramjet capable of operating on hydrogen fuel to speeds of approximately Mach 25.

(b) advanced materials in the airframe, engine and other parts of the aircraft that can withstand the high temperatures generated up to Mach 25 and still be completed reusable;

(c) a completely integrated engine and airframe that can operate effectively under a wide variety of speeds, temperatures, altitudes and flight conditions; and

(d) supercomputer technology capable of analyzing the aerodynamics of the integrated X-30 system.

The Administration approved on January 12, 1990 a joint teaming arrangement with all the major contractors currently working on the project. This will avoid a "down select" at the conclusion of Phase 2 and will preserve access to the best expertise of all parties.

Propulsion

Currently, the best airbreathing aircraft operate at speeds well below Mach 4. (Mach 1 is equal to the speed of sound which is 760 m.p.h. at sea level.) One concern has been the adequacy of facilities to test the scramjet engines at speeds (Mach 4 to 25) for which the engines have not previously been tested. The team has successfully tested one-seventh to one-quarter scale engines to Mach 8. Full-scale engine components have been tested up to Mach 6 and performances equalled and exceeded original expectations.

Advanced Materials

Some sections of the X-30 are projected to be exposed to temperatures of 5,000 degrees Fahrenheit or higher during flight. Existing aircraft materials cannot withstand such heat, so the NASP Program must develop new materials and active cooling techniques that have this capability and are reusable. Very good progress is being made by the NASP team which includes a unique management arrangement for a joint research effort by all the NASP contractors. In fact, for several materials, the normal fifteen-year cycle between laboratory experiment and structural fabrication was compressed to only four years.

Integration of engine and airframe

The effective performance of a scramjet will depend on the efficient flow of air into the engine, which in turn depends upon the shape of the airframe. The underside of the aircraft will be the air inlet to compress air for the engine as well as the engine's exhaust nozzle. Consequently, the engine must be completely integrated with the airframe. this may well be one of the most complex engineering integration problem ever undertaken. Nevertheless, the progress to date is very gratifying.

Supercomputer technology

Because of the advances in supercomputer technology, it is possible to analyzeq the integrated performance through computational fluid dynamics (CFD). As a result of the use of CFD, analysis of mixing, combination and engine performance is ahead of schedule. Results to date have indicated that propulsion systems for the X-30 are feasible up to the maximum speeds needed to low orbit entry. In turn, the X-30 experimental flight data are essential to validate the CFD calculations.

Congressional and other related activities

The Committee has supported the NASP Program, contained in the Administration's NASA budget request, every year since the creation of the program. The funding history is presented in Table 1.

TABLE 1. - NASP FUNDING
(in millions of dollars)

	Fiscal year--			
	1986-98	1990	1991	1992
DOD	569	194	163	233
NASA	237	60	95	72
Total	806	254	258	305

The President's Science Advisor, Dr. Allan Bromley testified at the March 12, 1991 Joint Armed Services - Science Committee hearing. He said "The National Aero-Space Plane is a sterling example of government-industry cooperation in advancing generic technologies that promise broad application in both the defense and the commercial realms. And, in my view, many of these technologies will be of key importance to our Nation's competitive standing."

Dr. Bromley went into more detail about the teaming arrangement. "The government-industry relationship is also unique in that government laboratories and research centers have responsibility for explicit pieces of work on the program's main development path. This is a significant departure from the customary generic R&D role of government researchers."

Regarding the expected 1993 decision to move to Stage 3, the actual construction of an aircraft, Dr. Bromley was very specific, "From everything I know of the program's maturity and progress, I would say that the national team should be in excellent shape to meet the Phase 2 exit criteria in FY 93.

"Once those criteria are met, I would be strongly in favor of moving forward to Phase 3. In my opinion, limiting our efforts to a generic hypersonic technology program after Phase 2 would not ensure that U.S. a technological lead. I also believe a generic technology program alone would not provide the foundation for an experimental flight vehicle program, because the highly qualified contractor team would be disbanded and integrated vehicle design activities -- the heart of hypersonic flight -- would cease."

J.R. Thompson, Deputy Administrator of NASA concluded at the March 12 joint hearing, "NASA remains very strongly committed to NASP. The NASA Research Centers continue to be a vital part of the dynamic national team for NASP technology development. We are pleased to work with the Department of Defense and the National contractor team toward their next major program milestone: the 1993 decision on whether to build an fly the X-30. We believe that the NASP epitomizes the type of advanced technology programs NASA and the Nation should be doing; pushing technology well beyond its current limits to help ensure continued U.S. aerospace preeminence."

Also during the same hearing, Dr. Charles Herzfeld, Director of Defense Research and Engineering at DOD, stated, "I'm pleased to offer my views on the Administration's strong commitment to pursue the goals of the National Aero-Space Plane (NASP) program. It is an important program to the Department and the Nation."

Dr. Herzfeld listed three important reasons why DOD supported the NASP program. "First, if the NASP program achieves its goals, the potential military benefits could be important. Vehicles derived from a successful NASP program could provide much needed rapid, cost-effective, flexible, and reliable access to space. They could also provide extended hypersonic atmospheric cruise capability for several candidate military missions. This is not only my personal view but the view of the Joint Chiefs of Staff the NASP program is strongly supported by the Strategic Air Command and the Air Force Space Command, again because of the potential military benefits that a successful NASP program would offer."

"Second, the current NASP technology development efforts will yield technology that is valuable in other areas of defense, including aircraft and missiles."

"The third reasons for continued DOD support is that the program is making good progress."

Dr. Herzfeld concluded with, "In summary, DOD remains strongly committed to the NASP program."

FACILITY MAINTENANCE

The Committee has had a long standing interest in the maintenance of NASA's facilities. For example, the Committee vigorously supported NASA's Wind Tunnel Revitalization Program. The Committee often has expressed a need for NASA to properly maintain its facilities in order to meet program objectives. Moreover, when performed on a timely basis, a first class maintenance program can reduce the need for major repairs at a later date.

The Committee congratulates NASA for being forthright and sincere in its testimony before the Committee on March 5, 1991 when Samuel W. Keller, Associate Deputy Administrator, testified for NASA that:

> *"I certainly would agree that Admiral Truly's comments that the state of our maintenance at the present time is the result of a large number of independent decisions that have been made over the years." Hearing before the U.S. House of Representatives, Committee on Science, Space, and Technology, March 5, 1991, Transcript at page 63 - 64.*

The Committee is disappointed, however, with NASA's defense of its present facilities maintenance management structure since that day. There has been no indication from NASA, that it intends to correct the basic problem of elevating the importance of facility maintenance within its management structure.

The Committee strongly believes that the authority and responsibility for facility maintenance should be centralized. Centralizing the authority and responsibility for facility maintenance should improve the condition of NASA's facilities in a short period of time and should be less costly than is currently the case.

The Committee finds NASA's maintenance responsibilities are fragmented throughout five organizations at the Headquarters level: Research and Program Management, three major Program Offices, and Construction of Facilities. However, while NASA's Budget Summaries specify funding for maintenance under Research and Program Management and Construction of Facilities, the Budget Summaries do not specify funding for facility maintenance under the Research and Development Programs.

Furthermore, while there is a Director Of Institutions in at least one of the Program Offices, and while there is a competent Director for Facilities within that organization, the degree of authority of that Director is unclear since the authority for expending funds seems to by-pass that person and go directly through to the Center Director. The December 1990 General Accounting Office's "Report to the Chair, Subcommittee on VA, HUD and Independent Agencies, Committee on Appropriations, U.S. Senate on NASA Maintenance: Stronger Commitment Needed to Curb Facility Deterioration" contained the following statement on page 21:

> *"NASA Headquarters has not provided comprehensive guidance to standardize the operation of the centers' maintenance management systems. Consequently, there is no standard maintenance system within NASA, and each center has developed its own approach to plan, budget, schedule, and report on maintenance requirements."*

For example, in two of the NASA centers, there are three separate organizations all related to facilities. The Committee is of the opinion *that organizational boundaries frequently lead to low morale and poor performance. Finally, at the Centers, institutional facility maintenance is included with security services, janitorial services and expenditures for utilities.*

In the opinion of the Committee, the age of NASA's facilities require somewhat higher investments in maintenance than has been made in the past. However, the Committee cannot, in good conscience, recommend any increase unless and until NASA establishes one single office at the Headquarters level accountable for and with the authority to develop and direct an effective facility maintenance program throughout NASA. The Committee looks forward to the appointment of a qualified individual to direct this program early in FY 1992.

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